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THE CHRISTOPHER COLUMBUS FESTIVALS.

THE celebration of the fourth centenary of the discovery of America by Columbus has begun in Spain. The caravel Santa Maria, constructed exactly after the model of the boat that bore Columbus toward the New World, started from the port of Huelva on the 8th of August, and steered toward the great Antilles, in order to follow the exact course taken four centuries ago by the great navigator. The caravel then left the coast of Europe accompanied by the Nina and Pinta, built by the American government. From Cuba all three vessels will sail to New York, there to take part in the festivities pertaining to the World's Columbian Exposition. As compared with our great steamers, the caravel, although it was the admiral's vessel of Columbus' flotilla, and one of the best ships of the fifteenth century, was in reality but a strongly built barge, with poop and forecastle, and gauging about 200 tons. It was capable of carrying a crew of 70 men. The sails as well as the oriflammes have been carefully reproduced. According to the drawings of a geographical map of Juan de la Cosa, the vessel carried a mainmast with the banner of Castille and Leon, and on the foremast the oriflamme of Columbus, that is to say, a green cross upon a white ground, with the initials of the Catholic kings surmounted by two crowns. Besides, in the admiral's cabin there was the ship's palladium, the banner of crimson damask with Christ's image, which, at the time of landing, was carried ashore and planted in the soil of America. We take occasion here to give the project for a monument to be erected to Columbus. A Spanish royal decree of February 26, 1891, ordered a competition among artists. Three sculptors responded to the call—Messrs. Font, Alsina and Melida, the last of whom gained the prize. Mr. Melida's work is, it must be said, a beautiful and noble conception. Four heralds, clad in the cope of mourning, carry upon their shoulders the draped casket in which will be deposited the ashes of Columbus that are preserved in the cathedral of Havana. The four heralds carry the insignia of the kingdoms of Castille, Leon, Aragon and Navarre, symbolizing the European possessions of Queen Isabella and King Ferdinand. The monument will be of enameled metal.

PROJECT FOR A NEW MONUMENT DESIGNED TO CONTAIN THE ASHES OF COLUMBUS.

As for the Convent of Rabida, near Palos, in the province of Huelva, that is, from the standpoint of the souvenirs of Columbus, the most interesting of the commemorative monuments, since in this very place he found an asylum at the time that he was preparing his project. It was there that he conceived the plan of it, and it was thence that he started for his first voyage. It was formerly an abbey belonging to the Franciscan fathers. The Spanish government has now undertaken the restoration of it, in order to convert it into a national museum.

Columbus dwelt in the Convent of Rabida in 1484 and 1485 and at different times up to 1491. For eight years he had, so to speak, no other fixed dwelling place in Spain. It was to the monks of the Rabida that, during his expedition, he confided his son Diego, who there received his education.—*Le Monde Illustré.*

SHALL WE EXAMINE?*

By CLARENCE M. BOUTELLE.

THE history of education, like the history of humanity in general, is a history of extremes and excesses. Educators will be fortunate, and I fear fortunate beyond their deserts, if the mature judgment of another age, in which the nineteenth century shall have become a part of ancient time, does not assert that it is a history of crime—crime against childish peace and comfort, the right of youth to the use of its time in the wisest and most economical way, and crime against the most sacred needs of the human soul—as well.

We like to congratulate ourselves on the position we have gained on time's slope—with almost nineteen hundred milestones between us and the great

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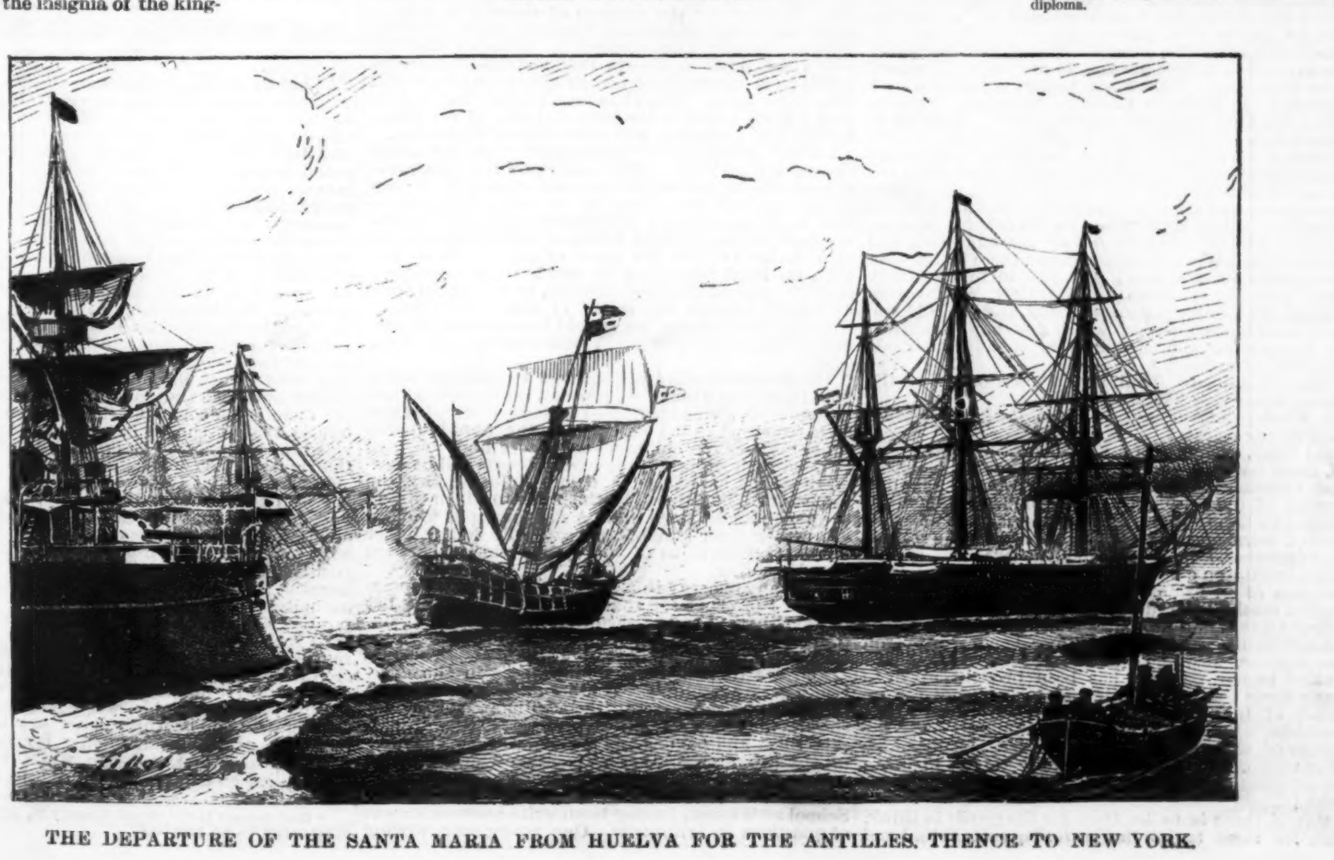
This essay was presented to the State Board of Examiners, who granted Prof. Boutelle his Iowa life diploma.



THE DEPARTURE OF THE SANTA MARIA FROM HUELVA FOR THE ANTILLES, THENCE TO NEW YORK.

life which made life worth living, culture worthy of endeavor, and true education possible. But I do not doubt that the human race is still young. I believe it is very young. Nations still fight, on occasion or without it, with the same unreasoning and reckless *abandon* as do the misguided boys upon our streets and our school grounds. Arbitration is too rare to be more than the hopeful dream of enthusiasts living a century or two too soon.

Now education should be in advance of statecraft—kingcraft. The stage of arbitration should be found by us, in our search for the new and the good, long before we should expect mankind in general to be even dreaming of it and hoping for it. To speak otherwise—to feel or believe otherwise—is to admit education a bit of a humbug, and assert modern educators the high priesthood thereof. Are we not, all things considered, behind the times, and falling farther and farther into the rear of Fate's fighting line in the battle of civilization?

We smile at the boy, curious, earnest, eager, but taught only by the narrowest of reading in the most condensed of text books, when he asks us: "Did the ancients do much of anything except fight?" Amusing? Perhaps so. Natural? Of course.

But what of us, when men of the future shall ask: "Did the teachers of old do much except examine and test and mark, grade and regrade and degrade, get per cents, and average and classify and compile them?" Natural? I—I am afraid so. Amusing? *Not by any means!* Some of us, with gray along the temples, which should index wisdom behind it, are as reckless as boys and nations are—and apparently belong to as youthful an epoch in the story of humanity. It is high time, is it not, for us to turn over a new leaf—*and not the leaf of an examination paper?*

Let us examine the question and see:

1. *What is gained by examining pupils?*

We gain a set of marks which we can average and compare and classify, and designate as "results." We gain the right to place before parent and pupil, in black and white, percentages and averages; we can insist that they are accurate, when a disappointed mother or an outraged child protests and denies; indeed, if protest and denial become too pointed and vehement, we can *prove* the position we have taken: we can *prove*, for appeal to the papers, already honestly and wisely marked, is final; beyond that—there is no appeal.

But is this gain? Is it fair to so regard it? Is it honest? Men's lives, women's works—these are the true results of educational thought and effort. "By their fruits" is the test—our test—as truly as it was ever test, or for any. And the marks obtained in the average examination are not mental fruits. Rarely, indeed, are they even fertile blossoms with promise of fruit. We can better afford to wait, in faith, a decade or two, for the "results" to work themselves out in the words and deeds of those we instruct, than to juggle with a mass of numbers which we know—and everyone knows—really mean so little.

No teacher can stand, day after day, for a year or a term, in the presence of a class of pupils, and fail to learn more of their ability, readiness, accuracy, honesty of purpose, continuity of effort, and the growth and development of power in the expanding soul, than any set of examination marks ever indexed—or ever can. And as for the other point—what of it? Is not the teacher's judgment as worthy of respect, unbolstered with marks, as when crutched and supported by them? What honest parent, face to face with an honest teacher, confronted with the fact that his boy cannot be promoted to a higher grade, would hesitate long in his choice between these two possible reasons: "Because he only reached so many per cent. in his examination:" "Because, day by day, he has been slow, careless, inaccurate—proving, as time has passed, that he has not the power, mental and moral, demanded by the duties of a higher grade"?

A gentleman said in my hearing, not long since, that a pupil unaccustomed to passing examinations in school would find the tests demanded of the man too hard for him to meet successfully, when he went out, armed only with the strength school had compelled him to acquire, to face life and its problems. I cannot agree with him. The world judges reputation and character. It gives its prizes to those who *can do*, rather than to those who merely *know*. Wishing to employ one, I had rather see a teacher conduct a recitation, observe a physician in the presence of grave danger, listen to a lawyer's plea—than to examine the one in the technicalities of grammar, one in the science of anatomy, and the other regarding his knowledge of Blackstone. It is, fortunately, for the future's promise, the way of the world—counting out education and civil service. What comparison can there be between the experiment the pupil performs in his chemistry class, with every sense on the alert, with reason aroused, with quick judgment ready, and the cold and dead examination paper, which has hardly touched the many-sided soul of the writer on any other side than that of memory?

What is gained? That is the question. And the answer seems very like *nothing!*

2. *What would be gained by abolishing examinations in our schools?*

(*a.*) Time. Examinations, if we must have them at all, must have much time given to them. To insist that examination papers must be written in a limited portion of time, is indirectly to condemn the whole system; for it is to assert that the test is to be no more than a mere memory test. To reproduce the reasoning of another, as laid down in some excellent gentleman's treatise on geometry, for instance, being the end and aim of an examination in that subject, and the pupil a machine for doing the required work, it goes without question that a time limit may be set without much difficulty; so many words per demonstration, on the average, must be written; the capacity of the trained human machine has been brought up to so many words per hour. Mathematics furnishes the solution of the problem: "How much time?" The would-be wise teacher adds something to cover the danger of scratching pens and broken pencil points; after which, there is nothing more to do but to drop a set of questions into the class, and see the machines work!

But if there is to be time for the pupils to think, time for them to let the reasoning seem actual and valid, time for them to sensibly fill any gaps where memory has been treacherous, then no mathematical calculation can fix on one hour, or on one hour and a half, or on two hours, for the time needed. I think that general experience has proved that pupils in a high school will need a half day in which to write answers to such sets of questions as are usually asked, for each subject, and each time they are examined. Allowing for such vacant half days, for some classes, as the programme for examinations will usually necessitate, it is likely that from two to four weeks per year will be *wasted* in examinations.

With many teachers and many classes, a large addition must be made to the time lost because of the so-called reviews which precede examinations. These reviews are demoralizing in the extreme. Teachers and pupils alike work with only marks in view, and passing and promotion are the only good in life—the mental horizon is filled with them, and there is neither time nor desire to see aught else. Work imperfectly learned, or never learned at all, is given to an overworked and unnaturally stimulated memory: "Keep this," is the demand made of that marvelous faculty of the immortal soul, "until such a day, at such an hour. Then you may rest—rest. After that you need care for it no more forever!" There is no pause of the mind possible, for a contemplation of its own activities, or an understanding and an appreciation of what is mechanically learned. An Alexander may conquer the world; what is he and his history but a bunch of dates and a catalogue of places? Newtons and Faradays may revolutionize science, and the pupil could only cry: "How could they?" Not because such wisdom is so marvelous—oh, no. Not because science has so benefited humanity—no, not that. "How could they?" when it has made science so much harder, and the dreaded examination so near? Time saved? Yes. Here and now, in the student days. And time saved in later years, too, if steady nerves and normally developed brains mean more of hope than their opposites.

(*b.*) Better teaching; teaching that is natural and honest.

How many teachers nowadays, with overcrowded courses of study, dare step far aside from the book and its tasks? Lists of names that no one cares to know, lists of dates that no one ought to know, a mass of geographical detail that would put a professional traveler to shame—all this is parceled out to the various grades in our schools—stones in lieu of bread, because, forsooth, the examinations are coming! We can do away with all this when the brightening eye and the ready lip, day by day, hour by hour, come to count, while easy-going indolence shall find a few hours of hard labor just before the test comes availing them, henceforth, nothing.

Let the student of history read or listen while his teacher or a classmate reads from some of the great writers who have made history real. Let him see the scenes, know the men, follow the real warriors to actual battle, or watch men and women at their firesides and in their fields, and I care little if he fails—sometimes—when I query, "When?" or "How many?" Why, unless because the examiner's questions throw a shadow upon his path, should the student care when this writer was born, when that one died, or of what trivial follies some other may have been guilty, while the words they used for the interest and instruction of their fellows are neglected, or only half studied, and that reluctantly and in a mental attitude of apology?

Why should not the teacher find it equally right and wise, sometimes, to step beyond the bounds his book sets to the subject he teaches, even though by so doing he loses some two or three of the precious days he and his pupils have in which to prepare for *the end?*

(*c.*) Readier and more practical scholarship.

I would do away with all examinations, to the end that all of school life may be one perpetual examination. Here reason, observation and all the other powers of the mind should meet on an equality with memory. Reviews for the purpose of passing on sets of questions being eliminated, frequent, short, informal reviews, usually unannounced in advance, and for which the pupil is always held responsible, and for which he is naturally and easily always ready, would take their place. What has been done; what can be done? these would be the tests, in place of an examination into imperfect, and often barren, knowledge.

I would require an increasing amount of judiciously chosen written work. Not so much to test the accuracy of acquirement as to increase it and fix it; not so much to fix a knowledge of the rules of punctuation, spelling, grammar and rhetoric, as to form in the minds of the pupils right habits of writing and expression—habits to take the place of any conscious reliance on fixed rules; not so much to test neatness, rapidity, thoughtful thoroughness, as to compel them all by and through the might of many repetitions—these are the reasons we should have in mind in asking our pupils to write, and write, rewrite and write again.

The powers of observation, under a newer and better plan than is now ours, will grow on into manhood and womanhood, instead of finding themselves dwarfed and disregarded when the big books in the hard branches stand between our children's eager feet and the goal they set their eager steps toward. Reason will be master in reality, as well as in name, while memory, the usurper, will be reduced to the rank to which God in the beginning assigned him. A class of pupils who can *do*, rather than stumblingly *say*, will find a firmer foothold on the ruins of the system which has been found wanting.

Does any one say this is visionary, unreal, impractical? I care not for that. Trial is the test. Let us have that. I am satisfied that honest, faithful, unprejudiced trial will find so much good in the change that it will never turn back.

And are there not enough instances in the experience of any teacher or examiner to serve to condemn the old? Can one recall them without blushing for the system which made them possible? Dare we narrate them and not demand a change—some change—*almost any change?* Let me mention a few instances, and discuss them in the light of these questions.

I examined candidates for admission to the Normal School at Winona, having them write answers to sets of questions in arithmetic. One young man, writing in the morning, and failing in cube root, undertook to explain why he failed; he had been over the subject; he had understood it; *he believed he could teach it;* but something in its complicated rule or formula eluded him. The one missing link made his chain of reasoning only a broken one. He failed. He admitted it. He only claimed that it was unfair. In the afternoon he returned to be examined in another subject. Then he knew cube root again; a few minutes had served to refresh the faulty memory which had failed at the critical time; reason found the missing link; the mind fully possessed its own again. Now it must be admitted that no one ever learned cube root in a couple of hours; it will be granted that the young man in question had no reason for stating what was untrue; in a word, he *forgot*—but, in the truest sense, despite all that, he *knew*. We should give credit, large credit, to the man who knows where to find and how to use more than he attempts to carry with him in his finite human brain, and to the *man*—the lawyer, the physician, the statesman—we do. We should accord praise to him who knows, usably, though sometimes he does not remember—and again and again we do. The child, struggling upward, reaching toward the light, groping for the best we can give him, relying with an utter and childish faith on our wisdom and fairness, should be treated as justly. He will be, when it is no longer the shame of our system that "the average is the child's god, and modern education is its prophet!"

I knew a girl to become puzzled over a question in an examination in algebra, and to work herself into such a mental state as resulted in her "falling below grade." And yet, soon after, she passed an examination on the same subject matter and stood 100. Mental strain accounted for the difference, and her teacher, virtually sworn to allegiance to the examination system, knew it all the time and protested against the injustice which could not be remedied short of a re-examination—*because one may not be partial, and the record must outweigh a teacher's judgment!* We teach hygiene in our schools; we assert that its principles are true; we ask our pupils to believe them and to live in harmony with them; and then, in the name of some of the higher branches toward which they, on mental tiptoe, ambitiously aspire, we proceed to set them lists of questions the real effect of which is to determine how strong nerves they have, how long and how hard they can labor, how much and how well their brain tissue can endure. I knew, I know.

But repetition is needless. *All* know. No teacher need search his own experience long to find instances which cannot but sadden him. Parents know. Some children know. The knowledge that the examination system is no true test, and that the teacher's observation lays hold on conclusions which it can never reach is spreading—spreading. It is the beginning of the end. Let us be grateful.

How does my child grow? Shall I measure him once a month, weigh him once a quarter, to determine whether he has grown at all?

How do the soul and mind grow? How shall I know? How measure and weigh the viewless gain? By touching memory sharply with the sting of compulsion, now and then? By giving spasmodic effort the palm, while plodding effort gets the credit of having gained naught?

Or, shall I watch lovingly, patiently, hopefully, looking at the face which mirrors the soul, and listen, day by day, to the story of what observation gains, of how reason uses, and how imagination improves and beautifies?

It seems to me there is only way—one true way: The way that saves time, the way that saves nervous energy, the way that secures symmetrical growth.

What do we gain by not examining? It seems to me we gain *everything!* I think "the coming teacher" will not examine. I have reason to think he is coming soon.

[FROM THE TECHNOLOGY QUARTERLY AND PROCEEDINGS OF THE SOCIETY OF ARTS, BOSTON.]

THE PHOTO-MECHANICAL PROCESSES.*

By S. R. KOEHLER.

As before stated, drawings in absolutely black lines on white paper, yielding a perfect black and white negative, are a necessity for all the processes so far examined, if the results are to equal the originals. Very admirable results have, indeed, been obtained from pencil drawings, and other drawings with gray lines, in cases in which an artistic indication is valued above mechanical perfection. But such perfection is often necessary, and still oftener the wish of the parties for whom the work has to be done. As, however, artists' drawings of the usual kind rarely if ever meet the requirements of the processes, these latter have given rise to a class of work specially known as "process drawing," and have brought into use a number of devices, such as grained and printed papers of a great variety of patterns, scratch paper, shading mediums, pasting tints, etc., altogether too numerous to mention here in detail, and worthy of special study. It cannot be denied that much of this kind of work so far done is hideous; but it is quite within the possibilities that it should be good and even refined, provided the right sort of designers will take hold of it in the right spirit.

In view of what I have told you so far, you will find it easy enough now to understand the making of a *photogravure*, that is to say, of an intaglio plate, from an original in black lines on white paper. All we shall have to do will be to use a straight black and white positive (a transparency) instead of a black and white negative under which to expose our plate coated with asphaltum or bichromated albumen. Under such a positive the black lines of the design will be protected from the action of the light, whereas those parts which represent the white paper on which the black lines are seen will be exposed to it. It follows that those parts of the sensitive film on the metal plate which represent the lines remain soluble, whereas those which represent the ground or white paper are hardened. The development will consequently lay bare the metal along the lines of the design, while it will leave the resist intact on all other parts of the plate, precisely

* Read January 14 and 28 and February 25, 1892. Continued from SUPPLEMENT No. 903, page 14430.

as if the lines had been drawn through an etching ground with a steel point, so that they can be bitten in with a mordant in the usual manner. The process is, in fact, simply a reversal of the relief etching process.

The use of asphaltum on a metal plate, exposed under a positive for the purpose of producing intaglio printing plates, forms the starting point of the history of the photo-mechanical processes and of photography. Joseph Nicéphore Niepce began his experiments in this direction in the year 1813; but he used crude asphaltum with oil of lavender as a solvent, and prints or designs on paper, made transparent, as printing screens (positives). An impression from one of his plates, made in 1824, and still preserved in the museum at Châlons-sur-Saône, can be seen in the United States National Museum at Washington. So far as known, this plate is the oldest specimen of photo-mechanical process work now extant.

The fact, however, that the intaglio processes can produce, as we have seen, not only black lines but also lines of other values—a fact upon which depends much of their attractiveness—makes the frequent reproduction of works in purely black lines by photogravure somewhat improbable, and as the processes so far described are incapable of anything else, we shall now have to consider those means which can give us gray as well as black lines. It is said, indeed, that Amand-Durand, of Paris, who is famed the world over for his beautiful reproductions of the engravings and etchings of the old masters, uses the primitive asphaltum process. If this statement is true it explains the very careful and elaborate retouching with the graver which his plates show, the photo-mechanical part of the work serving evidently only as a basis for that of the engraver. But, while this retouching does not in any way detract from the general beauty of the result, it utterly destroys its scientific value; so that it would be quite impossible, for instance, to rely upon an Amand-Durand reproduction for the identification of an old engraving of doubtful authenticity.

The problem, then, which next presents itself to us is this: How can black lines and gray lines be produced by photographic means on a metal plate which is to be printed on a roller or copper-plate press like any other intagliated plate? It is clear that such lines must differ not only in breadth but also in depth, becoming narrower or shallower, or both, in accordance with the shade of gray which they are to produce in the printing.

Poitevin proposed the *swell-gelatine process* for this purpose, with a positive, reversed this time, instead of a negative. With a "black and white" positive, like the negatives with which we have dealt so far, those parts of the film protected from the light, having been fully protected throughout, would swell to even height; and an intaglio plate made from a relief thus obtained would show lines of equal depth throughout, and hence printing equally black throughout. But the case is different with a positive which is not merely "black and white," but which shows black only where there is actual black in the original, and varies in density where there are grays of varying value. Now as the power of the gelatine film to absorb water, and consequently to swell, will eventually vary in inverse ratio to the amount of light that has acted upon it, it follows that it will retain all its capacity of swelling where it was entirely protected from the light, and that this capacity will decrease with the increase of the amount of light which has passed through the less and less dense portions of the positive until where the light passed in full force all the swelling capacity will have been lost. A bichromated gelatine film exposed under such a positive and then swelled will consequently present lines in relief, the height of which must differ in inverse ratio to the amount of light that has acted on them. A plate made from such a relief will, therefore, show lines which are deepest where they are to print blackest, and which decrease in depth where they are to produce lighter values, the breadth at the same time being regulated by the breadth of the lines in the original.

Another possibility grows out of the fact before noted, that *bichromated gelatine becomes impermeable to mordants in proportion to the amount of light that has acted upon it.* That is to say, where no light has affected it, it allows the mordant to pass most freely; where it has undergone the full effect of the light, it allows none to pass; and the gradations between these two extremes show corresponding degrees of permeability. Hence, if we expose a bichromated gelatine film on a metal plate under a positive—unreversed in this case—and then expose this film to a mordant (under conditions to which I shall have to refer later), the action of the latter will differ along each line in accordance with the variations in permeability produced; and the result will be lines bitten into the plate varying not only in breadth but also in depth, and consequently in ink-carrying capacity.

Quite different from any of the methods hitherto mentioned is the one introduced by Scamoni, of St. Petersburg, and named by him *helio-electrogravure.* It is based upon the fact that collodion negatives, and consequently also collodion positives, on glass show a perceptible relief. Such a positive, made from an engraving with collodion of a special quality, is so treated as to increase the relief of the lines as much as possible, and a plate is then made from it by electro-deposition. Considerable hand work is necessary, however, to finish the plate.

What may be termed a modification of the *wash-out process* has also been used for the reproduction of line work intaglio plates. A relief consisting of lines in hardened gelatine, differing in height according to the amount of light that has acted on them, is formed on a metal plate, and an electrotype made from this relief furnishes the printing plate. The process will be found described in Husnik, *Heliographie*, second edition, Vienna, 1888, page 60, etc. It cannot be understood, however, without some knowledge of the pigment or carbon printing process, to which I shall have to call your attention later on.

We have so far confined ourselves entirely to the methods used in the reproduction of *line work.* The rest of our time must be given to the study of the processes employed for making printable blocks and plates from *half-tone* originals, that is to say, originals which show structureless grays in flat as well as in gradated masses, such as India ink drawings, black and white gouaches and oils, water colors, oil paintings, and lastly, but certainly not least, photographs from nature. It will be best in this case to begin with the *intaglio processes,* not only because they are the first historically, but also because they are more easily understood than the planographic and relief processes. It would be very interesting to indulge in an historical survey, and to examine Niepce's experiments with asphaltum; Pretsch's photo-galvanographic process, which involved the reticulation of gelatine, etc.; but we must restrict ourselves, as the subject is too vast, and even the examination of the methods generally used at present is likely to claim more time than you have allotted to me.*

The methods just alluded to depend on the varying degrees of permeability retained by a film of bichromated gelatine spread on a metal plate after exposure under a half-tone positive. The comparative resistance to the action of a mordant of the various parts of such a film along a straight line may be represented by a curve, the highest parts of which indicate the points of greatest resistance, while the lowest correspond to those of least resistance. It goes without saying that the action of the mordant through such a film will reproduce the curve in the copper plate, that is to say, at the point of greatest resistance the plate will not be attacked at all; at the point of least resistance it will be attacked most vigorously, and, therefore, bitten away most deeply; and the various degrees of resistance between these two extremes will be represented by cavities in the plate, varying in depth with the degree of resistance. The bitten plate, therefore, contains the original picture transformed into a mould for a relief, the deepest parts of which correspond to the blacks, the less deep parts to the grays and those parts which have no depth at all, that is to say, where the surface of the plate has been left intact, the whites of the picture. Now, if we can fill this mould with printing ink, and then transfer the relief in ink thus formed to paper, we shall have a reproduction of the original in all its gradations from black to white. This is impossible, however, as we have seen, owing to the necessity of wiping the surface of the plate in order to clear the whites. The cavities which hold the ink being very shallow and broad, the hand or the rag with which the wiping is done cannot help entering them, and, therefore, removing the ink from them. It follows that the method is useless unless a grain or tooth can be given to the plate which, while it does not interfere with the gradations needed, will yet form a support for the hand or rag in wiping, and will thus enable the plate to retain the ink while its surface is being cleared. Various methods have been proposed and used for the production of this grain or tooth.

The first of these methods may be called the *photogravure screen process.* If we take a transparent screen of some kind which will transmit the light at regular intervals and exclude it between these intervals—a piece of woven stuff, for instance, or, best of all, a glass plate upon which have been ruled very fine black lines parallel to one another or crossing one another—and expose under it a metal plate coated with bichromated gelatine, the result will be that all those points of the film acted upon by the light traversing the openings of the screens will be hardened and become impervious to fluids. If we now expose a plate so prepared to the action of a mordant, this latter will bite through those parts of the film which have remained soft, and, consequently, will form pits in the plate; whereas it cannot act on the plate where it is protected by the hardened parts of the film, and the corresponding parts of metal will, therefore, be left standing in relief. Hence we have now a plate which consists of minute ridges of metal, even at their tops with the surface of the plate, with minute depressions between. If we ink this plate, then wipe it and take an impression from it, we shall find that it has held the ink very well, but that the impression is of the same quality of black throughout.

The question now is: Can we combine the gradated biting through a film exposed under a half-tone positive with the ink-holding capacity of a plate treated as just described? The desired result can be accomplished by first exposing the plate coated with bichromated gelatine under the screen, then exposing it a second time under the half-tone positive and then biting in (etching it). The screen secures the grain or tooth needed, and the half-tone positive secures the gradations in depth between the ridges of metal which form the grain; and as the mordant bites not only downward but also sideways, it reduces at the same time the size of the metal ridges in the darkest parts, while it leaves them broader in the lighter parts, the action varying according to the energy which the mordant exercises on the various parts of the plate. It will be seen, therefore, that the gradations produced are the result not only of the depth of the ink-holding cavities, but also of the quantity of metal left standing between them. This is the process called *photoglyptic engraving* by Fox Talbot, and patented by him in England in 1852. In the same patent nearly all the other contrivances are described which have since been perfected, and which have given their usefulness to the photogravure processes of to-day, most of which are based on them.

Other experimenters have also used screens in photogravure processes—among them Egloffstein, one of the earliest workers, if not the earliest worker, in this field in the United States; but it may be said that they have been practically abandoned, and that an aquatint ground laid on the plate itself has been substituted for them. Fox Talbot was again the first to suggest and use such a ground, but the method of forming the film in the photo-aquatint process of to-day is the result of developments which have taken place since Talbot's day.

The *photo-aquatint process,* the perfecting of which is generally credited to Klic, of Vienna, and by which the very largest part of the photogravures published at present are made, involves the pigment or carbon printing process, and we must, therefore, familiarize ourselves with this latter before we can proceed. The pigment printing process is an outcome of the desire to substitute a material promising more stability for the silver which forms the image in the "silver prints" of ordinary photography. The aim was to substitute carbon, which is the coloring matter of printing ink, or other stable pigments for the silver; but as these bodies are not affected, or at least not sufficiently affected, by light, their direct use was out of the question. It was seen, therefore, that they must be combined with some other matter which had the required qualities, and which might be removed after exposure in proportion to the action of light on the various parts of the picture. Of course, the removal of this medium would carry with it, also, the carbon or other pigment, and, as more or less of the medium was left, more or less of the carbon or pigment would likewise be left; and thus a picture in a permanent color—as far as permanency goes in mundane things—would result, its permanency depending, however, on the permanency of the medium. In the history of this process we have again a subject which might easily tempt us to linger over it, for it is exceedingly curious to see in it how long it generally takes mankind to find out what seems patent to every one after it has been found out. However, we must check ourselves, and be content with an outline of the process as it is practiced to-day.

The first step in the *carbon or pigment printing process* is to coat sheets of paper with gelatine mixed with carbon or some other inert pigment. In this condition the sheets may be kept for a long time. If a carbon print is to be made, a sheet of this paper is soaked in a solution of potassium bichromate, and dried in the dark. It is then exposed to the light under a negative, say a negative made directly from nature. Upon the removal of the negative after the exposure, the surface of the paper—of the "carbon tissue," as it is technically called—is still simply black, blue, or of whatever color the pigment mixed with the gelatine may have been. The light has penetrated most deeply where its action was strongest, that is to say, under the clear parts of the negative, and has hardened the gelatine as far as it has penetrated. In the other parts it has penetrated more or less deeply, according to the varying degrees of density in the negative, and has, therefore, also hardened the gelatine film to a greater or less depth. Under the densest parts of the negative it has left it entirely soluble, or, at least, very nearly so. Now I want you, if you please, to stop once more to do a little extra thinking and a little extra admiring.

What is the result of the operations I have just described to you? The result is that we have embedded in our film, which is so thin that we cannot measure it by ordinary means, a relief in hardened gelatine which in its variations of height represents all the innumerable shades and gradations of the original! The delicacy of such a relief is so extraordinary that we cannot realize it, and yet our reason tells us that it must exist when we finally see the result on white paper. Here again is one of those marvelous facts, one of those great wonders to which we are indifferent simply because we do not stop to think. The question now is, how to get at this relief; how to take it out of the surrounding mass of gelatine which has remained soft. The answer seems simple enough: Wash it out! But here an unpleasant difficulty presents itself. The sheet on which the film is spread was, of course, exposed under the negative on the film side. The action, therefore, began on this side, and it follows that the basis of the relief, that is to say, its back or flat side, is on top, while the soft gelatine which is to be washed away is between the relief and the sheet of paper which bears the film. If, therefore, the sheet were washed in the condition it is now in, our hardened gelatine relief would float away in pieces, and our labor would be lost. To prevent this disaster it is necessary to attach the sheet to a second sheet, film downward, by means which need not here be particularized, before the "development" or washing away of the soft gelatine takes place. This done, the relief has a support on its under or flat side, and, consequently, cannot float away. You will now understand from what I have told you that a carbon or pigment print is a film of hardened gelatine charged with a pigment, varying in thickness according to the depth of shade to be produced, and attached to a sheet of paper or some other substance, as, for instance, glass, in which case the resulting picture is called a carbon transparency. The process here described—the single transfer process—is available only in case a reversed negative has been used, or for subjects in which the question of right and left is of no importance. With an ordinary negative the double transfer process must be resorted to, that is to say, the development must be done on a temporary support, and the developed picture transferred once more to its final support.

We may now proceed with the examination of the *photo-aquatint process,* as it is generally practiced to-day. The first step will be to lay a dry aquatint ground on a metal plate. This is done by powdering the plate with some resinous substance, usually asphaltum, and then heating it just sufficient to make the particles adhere to it. The minute specks of resin thus fastened to the plate being indifferent to the mordant protect the plate from its action, whereas in the channels between them it goes on without hindrance. The aquatint ground, therefore, serves the purpose of the first exposure under a screen, as practiced in Fox Talbot's photoglyptic process. Over this ground is mounted a negative gelatine film made by the pigment printing process. To obtain this a reversed positive on glass (carbon transparency) has first to be made, the necessity for which will become apparent when the nature of the manipulations in the pigment printing process, which involve the turning of the film, are considered.

We have now a metal plate, generally of copper, with an aquatint ground laid on it to produce the tooth or grain, and mounted over that a hardened half-tone negative gelatine film, thickest where the biting is to have no, or the least, effect, and gradually becoming thinner in those parts in which it is to increase in depth, and therefore fit to regulate the biting in accordance with the gradations to be obtained. By way of parenthesis I may add here that the pigment in the gelatine film is not an absolute necessity. A clear gelatine film would do as well; but it is obvious that the pigment facilitates the operation of developing the film, inasmuch as it enables the operator to see more clearly what he is doing. The rest of the process requires no further explanation, so far as the principles involved are concerned, in the light of what I have

* Some details are given in the catalogue mentioned at the end of this paper.

already told you. A few words must be said, however, concerning the mordant used, and the manner of using it. Two kinds of mordants are employed for etching—effervescent, such as nitric acid, which evolve gas, and therefore bubble, and still, which act without effervescence. An effervescent mordant cannot be used in the processes which make use of a gelatine film as a resist, since the biting takes place *under* the film, and the bubbles, which rise with great energy, would consequently tear it up. A solution of perchloride of iron is therefore used, which is a still mordant. It is worth noting, also, that successive baths of varying strength are used for the biting. A concentrated solution of the perchloride penetrates only the thinner parts of the film, while a more diluted solution acts also through the thicker parts. The biting, therefore, is begun with a strong solution, which acts only in the darkest parts, and this is followed up with weaker and weaker solutions, which continue the biting in the darks, and at the same time carry it on gradually toward the lights. You will see from this that the gradations do not depend simply on the variations of permeability in the film, but that they are assisted by the succession of solutions of different density which are under the control of the operator. The biting having been completed, the plate is worked over, if necessary, with the burnisher, to brighten the lights, and with roulettes, gravers, etc., to strengthen the darks.

A modification of the photo-aquatint process, into which the pigment printing process does not enter, is known as *photogravure Gilbo.* A bichromated gelatine film is formed on the metal plate, and exposed under a positive. After exposure an aquatint ground is laid on top of the film and fixed by heat, as usual. The mordant is again perchloride of iron (or nitrate of silver); but instead of beginning with a concentrated solution, a weak one is first used, so as to produce the lighter shades upon the plate. The film is then removed and a proof taken. A second film is now laid on the plate, with an aquatint ground, and the biting is repeated. The second aquatint ground used is coarser, however, than the first, and the biting is done with a stronger solution, so as to leave the delicate tints as they were obtained by the first biting, while the depth of the middle tints is increased. The operation is repeated a third, and even a fourth time, etc., if necessary, with increasingly coarser grounds and stronger solutions, so as to give the final strengthening to the deeper shades of gray and to the blacks. The plate is completed by burnishing, rouletting, etc., as before.

There are other photogravure methods, but the tendency is to keep them secret. One of the processes, for instance, worked by Boussod, Valadon & Co. (formerly Goupil & Co.), of Paris, and invented by their technical manager, Mr. Rousselon, is understood to be a deposit process, the printing plate being produced by means of electro-deposition on a wash-out relief—a Woodbury relief, of which we shall hear more presently—charged with gritty matter. The beauty of the plates produced by this process is largely due, however, to the careful and artistic hand finishing bestowed on them.

(*To be continued.*)

CLOTH MEASURING AND RECORDING MACHINE.

A PIECE of cloth, whether cotton or woolen, is never of an exact length when it comes from the loom, and even if it were, the subsequent processes of bleaching, dyeing, or finishing would always lengthen or shorten it. Cloth has, therefore, to be measured before it is sold, and generally afterward, unless the customer has unusual confidence in the seller. After a piece has once been cut by the retailer its length is no longer known, unless a record is kept of the sales on a ticket attached to the piece, a practice which is too inconvenient to be followed, except in special instances. At stock taking every piece has to be measured, at an immense expenditure of time and labor. This is not only true of retail shops, but also of large warehouses where dress lengths are cut to suit customers. Probably every piece of cloth is, on the average, measured several times in the course of its existence, at quite an appreciable cost, the annual total in a large warehouse being a respectable figure.

The retail seller measures his cloth by the yardstick, unfolding it as he does so, and having, of course, to refold it afterward. In warehouses two methods are adopted. In one the cloth is pleated backward and forward, and at each turn a rod is put into the bight, with its ends behind fixed stops. These stops are so arranged that the pleats are exactly one yard in length, and by counting them at the end of the operation, the length of cloth can be ascertained. The more expeditious method is to use a measuring machine, in which the cloth is run round a roller of known circumference geared to a counting mechanism. If care be taken to bring the machine to the zero point before commencing, and to stop it exactly as the end of the cloth goes through, this is a very rapid and satisfactory apparatus. It does not, however, obviate subsequent measurings when the cloth gets into other hands.

There is now being introduced to the trade a new measuring machine, which not only takes the length of a piece of cloth, but also records it, yard by yard, on the margin. The advantages scarcely need to be pointed out. The chief of them is that the measuring never needs to be repeated. The retailer finds the piece he buys marked on the wrong side of the selvedge through its entire length. When he receives it he has only to unfold the last yard to see if the length corresponds with the invoice, and at any subsequent time he can see at a glance how much he has left. The whole trouble of remeasuring is done away with, and also the risk of making mistakes in cutting lengths to supply customers' needs. The cloth is not damaged in any way; many classes of goods, such as silks, are woven with a selvedge that has to be cut off before they are made up, while for others an ink is used for marking the figures that can be removed as easily and completely as the tailor's chalk from a coat.

The figures illustrate the machine, which can be driven either by hand or power. It will be seen that it contains a drum having a circumference of one yard, or one meter, around which the cloth is fed. Two belts running in contact with this drum keep the cloth close to it, and prevent slipping. These belts can be raised when a fresh piece is being introduced. There are also two leading-off belts, not visible in the figures, which prevent the cloth clinging to the drum and being carried round by it. Geared to the drum is a circular scale, which revolves with it. This is marked in two rows, 1 to 50 yards in one and 51 to 100 yards in the other. When the scale has made one revolution an index finger drops and points to the second row of figures, showing on which the reading is to be taken, the change being made by a cam.

The recording mechanism, which prints the length on the underside of the cloth, is at the left-hand end of the drum in Fig. 1. There is a circle of types, giving the numbers 1 to 100, arranged round a wheel. At one place in the circumference of the drum an aperture is cut, through which each type is extruded in turn. The type first comes in contact with an inking roller, which runs in contact with a circular inking plate, but does not touch the drum. This inking roller is situated below the drum. As the drum revolves, the type meets the underside of the cloth, remaining in contact with it for quite an appreciable time, so that the ink has ample opportunity of becoming transferred from one to the other. After this is accomplished the type is withdrawn, the type wheel is rotated, relatively to the drum, by an amount required to bring the next number opposite the opening in the drum, that type is extruded and inked, and the next number printed on the cloth. Fixed projections in the drum, touching the inking roller as they pass it, mark the cloth at intervals of one-eighth of a yard, or one-tenth of a meter.

The mechanism for operating the type wheel is not complicated. On the side of the wheel is a row of crown teeth, gearing into a pinion of two teeth on the end of a horizontal spindle. This spindle is always carried round with the drum, and its pinion, being in gear with the type wheel, obliges this latter to share its rotation. At the other end of the spindle is a locking device and a partial pinion. At one part of the revolution this locking device is tripped by a cam path fixed to the frame, and the partial pinion gears with a fixed toothed quadrant, and is rotated through half a circle, moving the type wheel one number forward. The extrusion of the types is effected by a lever pivoted to the drum. One end of this lever stands under the tailpiece of the type which is to be moved, and the other carries a roller which engages with two fixed paths. The first path causes the inking of the type, and the second the printing of the cloth.

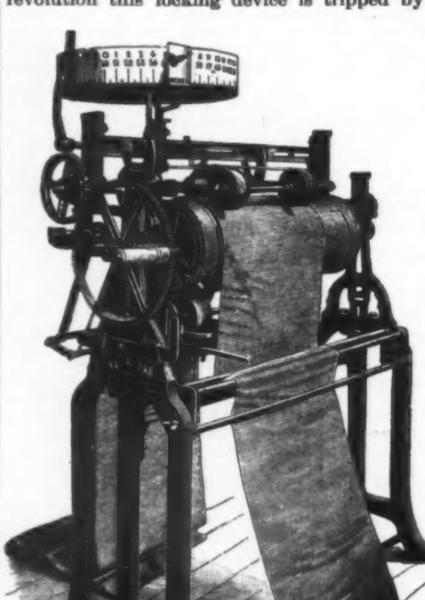


FIG. 1.

FIG. 2.

IMPROVED CLOTH MEASURING MACHINE.

The machine is arranged either to block or to plait the cloth after it has been measured. For the former purpose it is provided with a friction wheel and disk motion, the wheel being gradually moved from the center to the circumference of the disk by a ratchet arrangement. The plaiting motion is of the usual kind.

It scarcely needs to be pointed out what a revolution the machine will create in the warehousing and drapery trades. As we have already stated, each piece is usually measured several times in the course of its existence, and this means an immense labor in the aggregate. But this is of less importance than the feeling of uncertainty that prevails as to lengths, and the irritation that is engendered by "shorts." We may assume that wholesale houses never intentionally send short measure, but experience shows that there are still ample opportunities for disputes. The length of cloth depends on the tension to which it is subject, and a man's views as to what is the proper tension for measuring are apt to vary accordingly as he is buying or selling. Besides, errors may be made not only in measuring, but also in copying figures from book to book, and in making out invoices, and if they are against the buyer they create a bad feeling.

The facility afforded by the use of this machine for taking stock easily and rapidly is, perhaps, more valuable than the safeguard it affords against false measure. Many a business has become bankrupt simply because the proprietor could not afford the time, or provide the labor, necessary for stock taking. At best this is an operation that is cordially detested by all concerned in it, but when it entails the measurement and refolding of hundreds of pieces of cloth, and the keeping account of all sales between the time of measurement and the day on which the final quantities are taken, it becomes a most irksome and laborious matter. But with the length of every piece to be read off at a glance in yards and eighths, three-quarters of the trouble will be avoided, and the trader will not need to spend half his profit to ascertain exactly what he has earned.

The illustrations will show that the mechanism is perfectly simple and strong, and may be expected to run for years without any expense other than that for a few drops of oil per week. The machine was invented by M. J. Chevron, of Paris, and is already in use in the government factories and leading houses in France.—*Engineering.*

ASBESTOS.

DURING the past decade the uses of asbestos have become widely extended, and consequently brought to the knowledge of the great majority of those who live within range of our industrial centers. As a result of the wide applications of this substance, and of the interest excited in the minds of many by a "stone" which may be teased out into a fluffy mass resembling silk or cotton, there has arisen a somewhat extensive literature of asbestos. This is scattered through geological, chemical, technical and even religious publications, while there have appeared one or two not unpretentious volumes devoted entirely to this mineral. In these there are frequent statements which clearly indicate that the writers entertained serious misconceptions, and to call attention to some of these is the object of this paper.

1. There is a misconception as to the mineralogical character of asbestos, and this has arisen from the use of the name in a somewhat generic sense. Dana in his "Mineralogy" says that asbestos is a finely fibrous form of hornblende, but that much that is so called is fibrous serpentine. This statement seems to divide many of our writers into two camps, the one calling the mineral a variety of hornblende, the other proclaiming its serpentinous character.

The Canadian province of Quebec produces, it is estimated, about 85 per cent. of the world's supply, the balance coming principally from Italy. The products of these two countries are known the world over as asbestos, and it is not unreasonable, therefore, to ask that they be allowed to appropriate the name, even though they be of other composition than the mineral to which mineralogists originally applied the term, and that other minerals, if such there be, used for similar purposes, be otherwise designated.

The asbestos of commerce is a hydrated magnesian silicate of the same composition as ordinary serpentine rock; in other words, it is fibrous serpentine. It is curious to note, however, that the Canadian miners working continually among serpentine and nothing else have fallen upon the word hornblende, and apply it to a very coarsely fibrous and polished serpentine, such as is often met with along lines of faulting.

2. The second misconception is in reality but a special case of the first. It is to the effect that Canadian and Italian asbestos are different minerals. In the early days of the asbestos industry Italy was the only source of supply, and immediately prior to the discovery of the Canadian deposits a powerful company had been formed and had succeeded in bringing under one control the numerous small mines of the Italian district. Under the circumstances, it is not to be wondered at that the Canadian fiber found no favor in the eyes of the owners of the Italian mines. The Canadian mineral was declared to be far inferior to the Italian; the latter, it was maintained, is true asbestos, while the former is only fibrous serpentine. As a matter of fact, the two minerals are practically of the same composition, as is shown by the following results of analysis of fair samples recently made by myself: Italian—Silica, 40·30; magnesia, 43·37; ferrous oxide, 0·87; alumina, 2·27; water, 12·72; total, 100·53. Canadian—Silica, 40·57; magnesia, 41·50; fer-

rous oxide, 2·81; alumina, 0·90; water, 13·55; total, 99·33.

Canadian asbestos has largely displaced the Italian, not because of difference in composition, but by reason of the greater ease with which the former can be wrought into the various forms required in the arts.

3. The third misconception is that asbestos is in nowise affected by heat. This is set forth in such statements as "temperatures of 2,000° to 3,000° are easily withstood," and "a mineral which has been successfully exposed to a heat of 4,500° to 5,000° Fah." Now, what are the facts of the case? It is true that asbestos is infusible except at very high temperatures, but it is equally true that only a very moderate degree of heat, heating to low redness in a platinum crucible, for instance, is required to entirely destroy the flexibility of the fiber and render it so brittle that it may be crumbled between thumb and finger as readily as a piece of biscuit. In this connection, one is reminded that the ancients are said to have possessed asbestos napkins which they cleansed by means of fire, and that Charlemagne in like manner cleansed his table cloth, to the delight of his warrior guests. It is not improbable that these statements are to a large extent mythical; certainly, if true, the articles in question were not made of asbestos, the hydrated magnesian silicate.

4. The fourth misconception is that asbestos is possessed of high non-conducting qualities. This is perhaps the gravest and most widely spread of the several misconceptions, and is held by many who should know better. As an example of the manner in which this last misconception is set forth I may cite the following from an address of a well-known geologist: "Among the most important properties of asbestos is that of non-conductivity or its power of resisting the action of heat." Here we have the misconception clearly stated; it is that because asbestos is infusible it must of necessity be a good non-conductor. The truth is that asbestos itself is a very poor non-conductor, as any one may prove by placing a vessel of water on a sheet of asbestos cardboard and applying heat from below, or, more simply still, by placing a piece of wood on a sheet of asbestos millboard on a hot stove. If, however, asbestos is teased out and worked into a fluffy mass, we then obtain a non-conducting material, but it is the air inclosed by the fibers that is the real non-conductor, the asbestos serving simply to entangle the air. The use of asbestos in the manufacture of non-conducting coverings for boilers, etc., is due to its fibrous texture and its infusibility. The latter property gives it a decided advantage over hair and other fibrous materials which char under continued exposure to heat, while the exceeding flexibility of its fibers gives it a like decided advantage over mineral wool and other fibrous but brittle mineral substances.

The removal of the misconceptions to which attention has been called will in no respect tend to decrease the uses of asbestos, for the mineral has a sufficiency of good qualities of its own to maintain and increase the demand; while, on the other hand, a true conception of its nature and properties will prevent its use under conditions where only disappointment can follow; a circumstance which in the end would tend to bring discredit upon a most valuable mineral.—*J. T. Donald, in Engineering and Mining Journal.*

MACHINE FOR MANUFACTURING CORDAGE.

As well known, in the manufacture of ropes and cables, the yarn is first twisted into strands, which are afterward united into cords, and the latter, when assembled, constitute cables. The strands are invariably twisted in a direction opposite that of the yarns, and the cords opposite that of the strands, in order to prevent them from mutually untwisting.

The operations are performed either completely by one and the same machine, which simultaneously twists the yarns into strands and the latter into cords, or by two distinct machines, one of which twists the yarns, while the other twists the strands together to form cords.

Messrs. Walter Glover & Co.'s new machine belongs to the first of these two categories. It is capable of

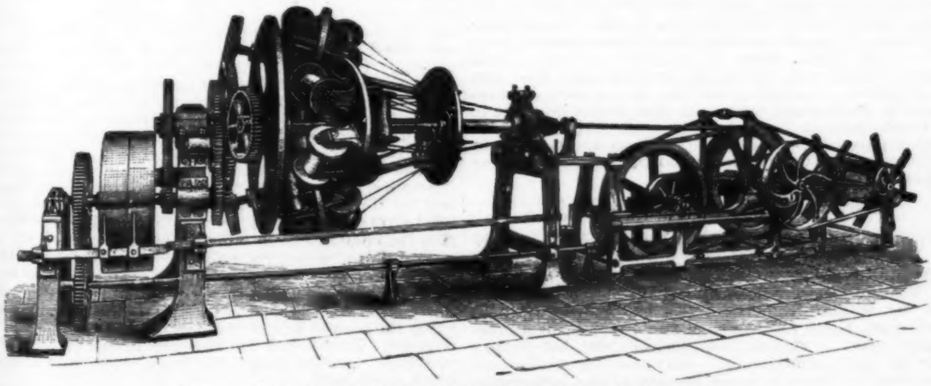


FIG. 1.—MACHINE FOR MANUFACTURING CORDAGE.

manufacturing all kinds of cordage of hemp, jute, silk, manila or cotton, from three strands, with or without a core, up to 87 mm. in diameter. As our engravings show, it is simple, and, as a whole, very compact. It can be operated by one man.

The 18 bobbins, *o*, with which it is provided are each armed with a special brake which can be regulated with the greatest precision, so that, during the reeling, the tension of the yarn remains invariable, this being an important point.

These bobbins are mounted upon three disks, *c* (three in front of and three behind each disk), which revolve between two others, *t t*, keyed upon the central axis, *a*. When the machine is in motion, the three disks, *c*, are carried along in a certain direction; but, by the combination of the gearings, *l b'*, they revolve at the same time around their axis, *b*, in an opposite direction. Each strand therefore receives the same tension.

When the bobbin yarns have each been twisted upon its own laying-top, the three principal strands that they have formed pass to a central laying-top, where they are twisted together. Thence they are carried along by polished drums and wound upon reels. It will be remarked that the three axes of the bobbin disks converge at a point situated a little beyond the central laying-top, so that the strands extend in a straight line up to the twisting without undergoing any deviation prejudicial to the regularity of the manufacture.

Duplicate wheels permit either of increasing or diminishing the torsion of each strand, so as to render it hard or soft at will, or to vary the twisting and manufacture the kind of cordage that one desires.

The drums and reels are moved automatically by the main shaft. They are therefore stopped and set in

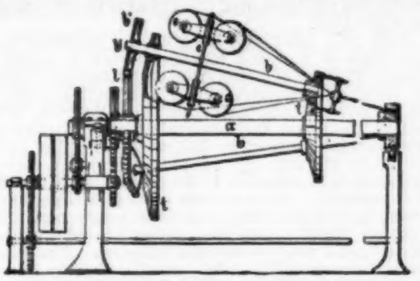


FIG. 2.—DIAGRAM OF THE MACHINE.

operation at the same time as all the other parts of the machine, and this prevents any differences of tension.

The whole machine is controlled by means of the starting lever placed near the twisting top. The machinists can therefore easily see each bobbin yarn and each strand at the moment it passes from the bobbin to its own laying-top.

There is a considerable distance between the particular laying-tops where the bobbin yarns are formed into strands and the central laying-top where the strands are twisted into a cable, and this permits the tension to be distributed equally and uniformly in the strands and helps to prevent kinks. With the same object in view, the builders have also left a great distance between the central laying-top and the drums.

All the bobbin yarns and strands converge toward a common center. So with this machine, there may be manufactured cordages that are neither too slack nor too rigid, as often happens in mechanical roperies.

Finally, the bobbins can be easily and quickly put in place, and the different parts of the machine are accessible without difficulty.—*Revue Industrielle.*

THE MANUFACTURE OF NON-POISONOUS WHITE LEAD.*

By PERRY F. NURSEY, Past President of the Society of Engineers.

INTRODUCTION—THE WHITE LEAD EVIL.

I DESIRE this evening to enlist your sympathies on behalf of a class of workers in one of our most important and extensive and, at the same time, most unhealthy industries namely, the manufacture of white lead. The pitiable condition of these workers is but little known beyond the immediate districts in which they follow their deadly occupation. I am satisfied you will give me your sympathies when I state that I ask them mainly on the behalf of girls and women, who, as a rule, take up this baneful work when they are unable to obtain any other employment, and they take it up, too, with their eyes open and with the knowledge that they are placing themselves face to face with disease and death. It would appear in some cases to be with them the alternative between death from starvation and death from disease contracted in earning their daily bread. That this is no overdrawn sensational picture you will all admit before I have proceeded very much further. Most of you have heard of lead poisoning, and perhaps some of you know by experience, either directly or indirectly, what it is. Few of you, however, are aware of the extent or nature of its ravages in white lead works—white cemeteries they are called in Newcastle. Not that we need go to Newcastle for experiences, for we have them in our midst here in London. White lead workers are almost entirely drawn from the ranks of women and girls of the poorest class. Skilled labor not being required, women and girls suit the purpose of the manufacturers, who only need some one sufficiently strong in physique and in nerves to carry a weight on the head and climb a ladder. And here I will close this chapter of horrors, but if any one should desire to pursue the subject further, he will find in the *Daily Chronicle* of December 15 and 21, 1892, some trenchant articles upon the present subject, which embody authenticated statements which cannot fail to startle the reader, while they will probably fill him with horror. Nor was the writer of those articles the first to attack the white lead evil. Charles Dickens long since, in his "Uncommercial Traveller," laid his hand heavily, yet truthfully, on this life-destroying occupation, showing how the workers undertake it with the moral certainty of having to exchange it, after a few years, for the hospital or the grave.

* A recent lecture before the Society of Arts, London. From the *Journal*.

But it is not only on behalf of those who make white lead that I ask your sympathy, but also in the interest of thousands of others who use it. The fact is that it leaves its mark more or less wherever it goes, and its path is a very broad one, for the use of white lead enters largely into many industrial processes, and is general as regards paint making and painting. In these respects it is productive of what is known as painters' colic, painters' paralysis, and other diseases.

AMELIORATIVE MEASURES.

The unhealthy nature of the white lead makers' calling has long been recognized, and spasmodic efforts have been made from time to time to ameliorate the condition of lead workers. Ten years since several boards of guardians directed the attention of the home office to the frequency with which cases of lead poisoning occurred. The Shoreditch Union led the way, and Poplar, Holborn, Gateshead, Newcastle, Cardiff, and other boards also took action. Shoreditch reported twenty-three cases of lead poisoning during eighteen months, and Poplar thirty during twelve months, while at Holborn no fewer than fifty-four cases were admitted to the infirmary. The medical attendant at one white lead factory reported that sixty-four cases of lead poisoning had been referred to him in nine months, while at another there were 184 cases between May, 1881, and October, 1882. In consequence of these representations, Mr. Redgrave, the chief inspector of factories, drew up a special report on the whole subject, and this was followed in 1883 by Sir William Harcourt's White Lead Act, by which provision was made for the protection of the operatives by the introduction of certain details of dress and sanitary arrangements. The act was well intended, but in view of the magnitude and deadly nature of the evil, has been found to be miserably inadequate. These troubles have also led to numerous attempts to modify the process, some of which have proved successful in ameliorating the evil to a limited extent. The fact, however, remains that this extensive and necessary industry is mainly carried on according to the old Dutch process of stacking, which annually claims a very large number of victims.

And here, perhaps, I may explain that the reason why white lead made on the Dutch system is so deleterious is that it is in the form of a white carbonate, which is highly poisonous. In the form of a sulphate, however, it is practically innocuous. Although the carbonate is regarded as an insoluble salt—being less soluble in some waters than even pure lead—it is readily acted upon and dissolved by the animal and vegetable acids of the food during digestion. On the other hand, white lead, in the form of a sulphate, is much less easily decomposed, being capable of resisting the chemical change in the stomach, so as to render it absolutely non-poisonous. As a matter of fact, in cases of lead poisoning, dilute sulphuric acid is administered by means of which the soluble carbonate becomes converted into an insoluble sulphate. The White Lead Act of 1883 prescribed acidulated drinks, as a means of resolving the carbonate of lead that had been swallowed into a harmless sulphate.

THE DUTCH OR STACK PROCESS.

I have said that attempts have been made to modify the ordinary process of carbonate manufacture, and these have for the most part aimed at reducing the time occupied in the production of the white lead, and in so conducting the manufacture that the lead had not to be handled at dangerous stages, and that the operations involving danger were carried out in such a way that the poisonous atoms were prevented from finding their way into the atmosphere. Some of these improved processes have been inspected by me, and I purpose describing them as marking the steps of progress. Before doing so, however, I will give a brief outline of the Dutch or stack process, which is carried out on the same main principles in all lead works, save in respect of a few matters of minor detail. In this process lead ore is first converted into pig lead, and the pigs are then melted and moulded into small perforated thin cakes, which are placed in stacks and submitted to the action of acetic acid, carbonic acid, and air. These stacks are built up in the following way: First are laid rows of small earthenware pots filled with acetic acid; on these are piled the lead cakes, then a layer of tan, and then one of deal planks. The women and girls who carry on this work continue these layers of acid, lead, tan and planks, until a height of thirty feet is reached. The tan begins to ferment, and the acetic acid, volatilized by the heat, acts on the surface of the lead, which in about four months is reduced to a carbonate, so that when the women enter the stack to remove it, they find a core of blue lead with a crust of white material adhering, and this is white lead in the rough. These beds simply breathe out poison, and the women cannot avoid the dust settling on their persons and their clothes. It clings to their skin, it gets in their hair, and in spite of overalls, respirators, and other contrivances, it finds its way into their systems, in due time effecting its insidious work, and leading, sooner or later, to consequences more or less fatal. After removal from the stacks, the white lead is ground in water and finished in drying stoves, these operations adding about three weeks more to the protracted period of manufacture.

From my youth up I have been taught that—

"For every evil under the sun
There is a remedy or there's none;
If there is one, try and find it,
If there's not one—never mind it."

There are no remedies for storms and tempests, and other convulsions of nature, nor have we yet discovered the art of bottling down volcanoes. But for the white

lead evil there is a remedy, and we will now try and find it.

THUARD'S PROCESS.

The first idea of a remedy appears to have been the quickening of the process of production. Going back to the end of the last century, we find M. Thuard, a French chemist, demonstrating that when a basic solution of a salt of lead, produced from lithal, was submitted to the action of carbonic acid gas, a carbonate of lead was precipitated. The white lead was produced in a few hours, and the process admitted of being carried on continuously at little cost. This has been the basis of many of the improvements since made in the production of precipitated lead. At the first this method was thought to meet all requirements, but it soon became evident that the quality of the lead was inferior, and it was shown that white lead so made was, as compared with stack lead, of far less specific gravity. Chemical analysis showed it to differ considerably, and that the particles of which it was composed were semi-transparent crystalline, while those of stack lead are amorphous and opaque, and consequently, it did not cover well as a paint. The advantages of the precipitation process, however, were admitted to be so great in point of time and economy that attempts have continually been made to remedy these defects, and to make the quality of precipitated lead equal to that made by the stack process, but, hitherto, without success.

THE MARTIN PROCESS.

The first pronounced departure from the conventional method examined by me was the Martin process, which was started on a working scale in 1880, at a large factory in Ossory Road, Old Kent Road, London. At the time of my visit to these works, in 1881, pig lead was first melted, and run through a series of small spouts into a revolving cylinder, the lead cooling in the form of flat spots, or "splashes" as they were termed. The splashes were delivered into a series of trays, and over them was pumped, through traveling spouts, a weak solution of acetic acid. The product was acetate of lead, which was further treated for white lead. The use of metallic lead, however, has been discontinued, and in its place oxide of lead or litharge is now used, the remainder of the process being unaltered. The litharge is dissolved in a solution of acetic acid, the product being acetate of lead, which, as fast as it is formed, is pumped into vats, where carbonic acid gas is forced through it. By this means, a precipitated carbonate of lead is formed, which is pumped into a series of filter presses, where the lead is separated from the liquor and retained in the filter bags. The white lead, which has now assumed the consistency of clay, is removed from the filter presses by the workmen with special knives. Up to this time, the lead has been moved about by the aid of machinery, and although manual labor now becomes necessary, the workmen do not touch the white lead, which is removed on trays to a vertical pugging mill, where it is treated with pure water, to wash out all the acid. From the vertical mill the lead solution flows, after a given time, to a horizontal pug mill, where the last traces of acid are washed from it, and it is allowed to settle. The lead is then pumped into a second set of filter presses, where it is finally filtered for drying. Up to a certain point in the process, the lead thus made is deficient in body or covering property, but this is imparted to it at one of the stages by the addition of a solution of lead in a particular chemical form, which gives it the desired body, and renders the process perfect.

From the second series of filter presses, the white lead, which has again assumed a clayey consistency, is removed on trays to the drying apparatus. It is there fed into a hopper, whence it falls through a pair of revolving rollers on to an endless traveling canvas band passing over a long series of steam-heated cylinders. At the end of the journey it has parted with nearly all its moisture, only about 8 or 9 per cent. remaining in it, sufficient, however, to prevent any dust being formed. It is then delivered into a closed and steam-heated tunnel, in which an Archimedean screw or creeper conveys it to a grinding mill, where it arrives quite dry. It is now ground under a pair of edge runners, and discharged at intervals into barrels, ready for the market, the whole of the operations being conducted without any dust creeping into the air, as the mill is inclosed, and the discharging arrangements such that the fine particles are precluded from finding their way into the outer atmosphere. It will thus be seen that, from first to last, although a carbonate of lead is produced, the elements of danger from contact or inhalation are carefully, and I believe successfully, guarded against, and that in this important respect the process is one which entirely meets the requirements of humanity. At the same time, a good article appears to have been produced in a few hours instead of many weeks. From recent inquiries I find that these works have been temporarily stopped.

THE LEWIS-BARTLETT PROCESS.

The next system which came under my personal notice was the Lewis-Bartlett process, which is noteworthy for containing in one, two previously distinct manufactures, viz., the production of pig lead and white lead. The ore is volatilized by heat combined with a current of air, by which the lead fumes are carried forward and ultimately condensed or solidified, instead of being discharged into the air, the final result being a sublimed white lead of very fine consistency and good covering property. The system was introduced into this country from the United States by Messrs. John Hall & Sons, of Bristol, and was carried out by the Bristol Sublimed Lead Company, at their works at Avonmouth, where I inspected the process in 1886. The dressed ore is delivered on the works from the mines, and is first fed into a furnace of the double Scotch hearth type, known as the "Jumbo." The ore is mixed with a small proportion of slack, to maintain combustion, and a small dose of lime is occasionally added. The blast is supplied by a blower, and as the ore is smelted, the molten lead runs into a basin in the hearth and flows over into a receiver, from whence it is cast into pigs. As the slag is removed from the furnace, it is passed on for further treatment in another furnace, where we shall presently rejoin it. The products of combustion, under the name of "fume," are drawn from a furnace through a tube by a fan. Passing through the fan, the fume is driven forward through another tube to the bag room. This room has a floor formed of iron plates, in which is a series of circular holes, each about 2 feet in diameter. Over each of these openings is a coarse woolen bag, 30 feet long, of the same diameter as the opening, and suspended from the roof by its upper end. About three feet below this floor is a series of iron hoppers opening into the room below. The fume, under pressure, enters the space between the tops of the hoppers and the underside of the bag floor, and is forced up the bags. The flue dust collects inside them, but the sulphurous vapors find their way out through the bags into the room by percolation. When a sufficient quantity of lead has accumulated, the blast is shut off, and the sublimed lead, or "blue fume," as it is called, falls into the hoppers and is run out thence on the floor below.

We have now a light fine powder of a bluish tinge, some of which is used for making lead-colored lead paint. The bulk, however, undergoes further treatment for the production of the ultimate result—namely, pure white lead.

I must now take you back to the smelting house, where there is a second furnace, known as a slag eye furnace. Thither the slag from the "Jumbo" and the blue fume are brought, mixed and fed into this furnace. The blue fume falls from the hoppers in a light powdery condition, the removal of which in this state would involve danger to the workmen. Before it is removed to the slag eye furnace, however, a shovelful of live coal is thrown on to it at one end of the floor, and this fires it. By a process of slow combustion it is converted, without detriment, from a light powder into a compact friable mass of a yellowish color, which is easily dug out and loaded into barrows. The mixture of blue fume and slag is fed into the slag eye furnace, from which a small quantity of metallic lead is here produced, the slag running off in a molten state as formed, and the fume being drawn off by a fan and forced onward through two settling towers and a series of bent pipes, known as "goose necks," to a second bag room. This room is similarly constructed to the first one, and the fume is driven into the bags in the same way, and when the blast is shut off, the solid particles fall into the hoppers. They are withdrawn thence through traps into receptacles below in the form of sulphate of lead. I cannot say whether or not these works are still in operation, not having received any reply to my letter of inquiry on the subject, although I have been informed that the process is not now being worked.

THE MACIVOR PROCESS.

A few years since Prof. Emerson MacIvor made the discovery that litharge, or oxide of lead, was soluble in a certain alkaline solution, which hydrated the lead, and that, when in this condition, the hydrate combined with carbonic acid gas and formed white lead, or a true basic carbonate of lead, liberating the alkaline solution, which was recovered to attack fresh charges of litharge. This principle was developed into practical form at some experimental work in the Clapham Road, London, which I visited in 1890. In this process the litharge is first prepared from lead ore, and is thoroughly purified by washing. A charge of the pure litharge is then put into a closed vat, in which are revolving stirrers, and a solution of acetate of ammonia is added to it.

This mixture is agitated for six hours, at the end of which time the lead will have been wholly absorbed into the ammonia solution. It is then allowed to settle, and the supernatant liquor containing the lead is pumped over into a second vat, similarly constructed to the first one. In the second vat the solution is submitted to the action of carbonic acid gas, when the pure white lead is precipitated from the acetate of ammonia, which is thus recovered, and is ready for use again. The mother liquor is run off, and the white lead is passed through filter presses, to deprive it entirely of the mother liquor. The pressed lead then goes to the washing apparatus, where it is agitated for a time in a bath of cold water, and is then allowed to settle, when the water is drawn off. This process is repeated eight times, when the white lead is found to be sufficiently washed. It is then again passed through filter presses, and is finally submitted to hydraulic pressure, in order to extract all the moisture capable of removal by mechanical means. From the hydraulic presses the white lead, which is a carbonate, is taken to the drying room, where it is dried at a temperature of from 160° to 180° Fah., when it is ready for use. It is claimed that by this ammonia process white lead can be produced at a cost below that of the pure lead required to make stack lead, and that it can be made in six hours, against four months by the old system. A further point is that all the operations are carried out in the wet way, so that there is no dust and less danger to health.

THE IMPROVED MACIVOR PROCESS.

In the course of developing this process into practical form, it was found that it did not contain all the elements of success. It was, however, improved by Dr. MacIvor, in conjunction with Prof. Watson Smith and Mr. William Elmore; and a factory was built at Northfleet, Kent, for working the process on a commercial scale. I visited these works in 1891, before they were in full operation, but only saw the white lead produced by means of model apparatus on a large scale. In dealing with a volatile agent like ammonia, it is imperative that the chemical engineering be of a perfect kind, so as to secure as little loss as possible, and this was one of the features of the improved MacIvor process.

The original process had been improved in such a manner that even from very inferior grades of litharge it was stated that a chemically pure white lead is produced. It is, moreover, so produced that not only is the acetate of ammonia used continually returned—*i. e.*, kept in circulation—with but a small percentage of loss, but from the entrance of the litharge into the digesters to the exit of the finished product ready for drying, the whole process is conducted in closed apparatus, and the work goes on automatically. In reply to recent inquiries, I am informed that the process has since been worked on a commercial scale, although the output has not been a large one. Pending the reconstruction of the company owning the patents, the factory is at a standstill.

FREEMAN'S INNOCUOUS WHITE LEAD.

The white lead evil has also been dealt with in a practical manner by two other manufacturers, with whom I have communicated in order to obtain particulars of their special methods of manufacture, so that my paper might be as complete as possible. In one instance I have been requested not to refer to the manufacture, and I, of course, respect the wishes of the parties. In the second case I did not experience such reticence, and particulars of the process were sent me. This is Freeman's "innocuous white lead" process, which is carried out at works in Hatcham Road, Old Kent Road, London, which works I have not had the opportunity of inspecting. It is hardly necessary for me to state that Messrs. Freeman are among the oldest white lead manufacturers, and they have been fully alive to the evils incidental to the stack system. In their process the molten pig lead is poured through a machine, which quickly transforms it into small flakes, on an inclined plane, up which it is carried and thrown off. The lead is then collected and placed in vats, which are specially constructed to produce rapid oxidation of the metal.

An acetic acid solution is then introduced to the mass; and for every five tons of lead so treated sufficient is carried down, in the form of a liquid, each time it is drawn off, to produce 900 pounds of lead. Sulphuric acid is then introduced into the liquor, when the sulphate of lead is deposited as a white precipitate. This is taken out and washed with water and deposited in vats. When these vats are nearly full they are emptied of the sulphate of lead, which is of the consistency of a thick paste. It is then dried in the usual way, and to it is added a certain proportion of oxide of zinc. It is then submitted to special treatment, whereby a complete change is said to be effected in its properties, a body and density much in excess of that of the ordinary white lead being imparted to it. It is stated that the compound before treatment weighs only 112 pounds per cubic foot, but that after treatment it weighs over 200 pounds per cubic foot. Its color is said to be whiter than that of any other lead, which is probably due to the zinc, and it is said to be highly approved of by users. It will be seen, however, that whatever its excellences—and I do not for one moment question them—this is a compound of sulphate of lead and zinc.

THE NON-POISONOUS PROCESS.

I now come to the latest process of which I have a personal knowledge, and which I had the gratification of inspecting in operation in January last. This is a sublimation process, which has been for some time past carried out on a commercial scale at the Caledonia Works, Possil Park, near Glasgow, which belongs to the White Lead Company, Limited. The theory of the process is based upon the rapid oxidation of the galena, which is a sulphide, into sulphate of lead, and its subsequent condensation, washing and drying, and it is carried out by the aid of a plant consisting of a number of subliming furnaces and accessories. Each furnace measures, internally, about 3 feet 6 inches by 4 feet deep, and the fumes pass through a narrow outlet into a combustion chamber beyond. The furnaces are connected up in groups of six, with a main flue leading to a tower and special condensing apparatus. The sulphate of lead is made direct from the dressed ore, which is received at the works from the mines in a condition, for the most part, sufficiently fine for subliming without having to be ground. The bulk is, therefore, simply riddled, and the larger portions ground. In starting a set of furnaces, they are lighted overnight, and are in good order for charging early in the morning. The coke bed is brought up nearly on a level with the upper sill of the furnace door, and the ore is then distributed over its surface in quantities not exceeding two or three shovelfuls at a time, the efficacy of the process being dependent upon the rapid volatilization and resultant oxidation of the ore. This operation is conducted so successfully that, I am informed, 108 per cent. of the entire charge is converted into its equivalent of white lead.

The proportions used in actual practice are one ton of galena to under one ton of coke, the latter containing about 5 per cent. of ash. The action in the first chamber consists in the oxidation of coke or carbon, mainly into carbonic oxide, and the rapid volatilization of the sulphide of lead, which compounds, on entering the second or oxidizing portion of the furnace, are converted repectively into carbonic acid and sulphate of lead. During the charging, no ore is thrown on until the previous charge has disappeared, as otherwise the fire tends to get choked and to lose its heat.

The fume passes from the furnace to the furnace flue, where it meets a blast of air intended to complete the oxidation of any volatilized galena or coke dust. At the end of the main flue the gases are conducted through a tower about 20 feet high, into iron flues 3 feet in diameter, terminating in an iron box, containing two steam injectors, by which the gases are forced into the condensers, in which there are three compartments, and in which the gases are absorbed into water. Each condenser is constructed of wood, and is lined with fire brick in order to resist the heat. The fume, now mixed with steam, is forced under the flies, and gains the second box of the condenser through a brick channel. In this box the flies are bricks with vertical openings, through which the fume is forced, a portion being condensed.

In the second box the heat is not so great as in the first, and the wooden walls are simply lined with sheet brass. From the second box the fume reaches the third and last, which contains wooden flies, with a much narrower aperture than those in boxes 1 and 2. The waste gases are conducted into a downcast, communicating with a stack 175 feet high. In order to compensate for evaporation, the condenser is fitted with a cistern and ball cock, so as to secure a continuous flow of water. The contents of the three boxes are discharged into the washing vats at suitable intervals, and are then thoroughly washed with slightly acid water to convert any oxide into sulphate. The product is then further washed to free it entirely from acid and impurities, and then, after settling, the white lead in the form of sludge is pumped over into the filter presses, and subjected to a pressure of 90 pounds per square inch. In these presses most of the water is got rid of, the product when removed from the press bags being pure sulphate of lead containing from 10 to

15 per cent. of water. This is then placed in earthenware pans in the drying rooms by women and girls, and dried at a temperature of about 120° Fah.; and after this operation the lead is taken into the packing shop, where it is packed in barrels for the market. I may mention that in addition to the foregoing treatment a method of mixing the sulphate with a hydrated oxide of lead has been adopted, so as to render the product equal to the best pigments for use in the trade. The lead is also worked up with oil and sent out as white lead in oil; it is likewise made into pigments of various colors, and sent out in cases ready for painters' use.

It will be seen that the reduction of the time of manufacture has in this process reached the lowest possible limit, inasmuch as the production of the white lead sulphate in the first stage is a matter of minutes as against months in the stack process. The new process, moreover, is eminently practical and simple and does not involve the use of intricate or expensive machinery or apparatus. As regards the quality of the white lead produced, there appears to be a consensus of opinion among many who have used it, as to its uniformity and superiority as regards color, covering power, and permanence. I have seen a number of testimonials from well-known companies and firms who have used it, and who all write of it in the most satisfactory terms. It is also found to answer well as a paste for paper stainers, for which purpose it has double the covering power of carbonate, or any other white pigment. It is also successfully employed as a distemper.

But however rapidly and cheaply the new white lead may be produced, however simple the process, and however excellent the product, all these recommendations must go for nothing, from a humanitarian point of view, if its manufacture and use were not innocuous, and unattended by danger to health and life. In other words, the sole recommendation of the process and the product, from the point of view I am taking, is that they practically secure immunity from a scourge, the character of which I have sufficiently indicated in my opening remarks. So far, however, you have only my word for its innocuous character, and I cannot pretend to speak with absolute authority on this point. One thing, however, I may say in support of my convictions, and that is that the operatives at Possil Park—men, women, and girls—presented a healthy appearance, nor could I, from inquiry among them, elicit an unfavorable opinion of the manufacture. This, you may urge, is little better than negative evidence. But I took care to obtain positive evidence upon the subject, for I inquired of Dr. Muir, the medical officer to the works, openly, and before a number of gentlemen who were present, as to the general sanitary condition of the workers. That gentleman stated that during his four years' experience of the process, he had not met with a case of illness which he could trace to the manufacture of this sulphate of lead; while he considered the possibility of lead poisoning among the workpeople to be most remote. Beyond this, there is the independent testimony of Dr. Farr, late Officer of Health for Lambeth, who has inspected and reported upon the works from a sanitary point of view. He expresses himself as being satisfied with the safety, as regards health, of those engaged in the manufacture of this sulphate of lead, as well as those who have to use it. He says in his report: "If a physician were called upon to attend a case of lead poisoning by carbonate, he would administer sulphuric acid, in order to convert it into a sulphate or insoluble form of lead. It is obvious that the white sulphate of lead, therefore, carries with it, so to speak, the antidote to the poison. On humanitarian grounds alone, it should command the serious attention of the Local Government Board and the Board of Trade, and its use should be insisted on."

CONCLUSION.

I have taken you back a century to the earliest improvements in white lead manufacture, beginning with Thuard in 1790, and, passing over the intervening space, have traversed the last decade, ending with the White Lead Company, Limited, in 1893. I do not pretend to have brought under your notice every detail of improvement, nor every process that may have been proposed or even adopted. With the exceptions stated, I have confined myself to matters within my own knowledge and observation, which, however, I trust will be found to convey sufficient information for the present purpose. My object is to expose a plague spot in British industries, and to point out a remedy. From what I have stated it will be seen that much time, thought, and money have been expended by inventors and manufacturers in their endeavors to cope with the white lead evil. In this there has been some success. The fact, however, remains that the protection afforded by the improved processes only affects the workers in a moderate degree, and the users and the public not at all, inasmuch as for the most part the poisonous carbonate is produced. The one exception appears to be the production of a harmless sulphate in the place of a poisonous carbonate, and it would seem that, according to the latest improvements, all the properties which have for so many years made the carbonate valuable can now be produced, even in a higher degree, in the sulphate, and this affords protection to all who make it and all who use it. For these reasons, I consider that, in its results, the Possil Park process is a decided advance upon the others which I have examined. I, moreover, consider it equally an advance in itself, inasmuch as it is simple, direct and rapid, and, so far as my observation goes, economical.

But, while inventors and manufacturers have been seeking to solve the problem, there have not been wanting those who, upon humanitarian grounds, have endeavored to ameliorate the lead workers' hard lot, by compelling the introduction of precautionary measures. These measures are, however, at the best, insufficient to stay the ravages of disease and death; for, notwithstanding the development of improved processes of manufacture, the bulk of the white lead now made is still produced by the stack process, with its attendant troubles. But public attention has once more been directed to the matter, and it appears likely to receive the attention of Parliament during the present session. On the 17th of February last, Mr. Swift MacNeill, in the House of Commons, drew the attention of the Home Secretary to the question, and asked him what steps the government intended to take to investigate and, if possible, prevent the loss of life in white lead factories. Mr. Asquith said that the matter had for some time engaged his attention, and that with the co-operation of the Board of Trade, he had arranged for the institution of an exhaustive inquiry into the case, both in its industrial and its sanitary aspects.

So far this is encouraging, and it is in respect of this proposed inquiry that I ask the active sympathies of all who can assist in promoting this philanthropic object. A thorough investigation will disclose the fact that the white lead industry lays a heavy burden of disease and suffering upon the bulk of the workpeople engaged in it. Such a revelation should oblige the government to adopt measures for superseding the ordinary stack process by one or other of the systems I have described, provided no better offers when the time for action arrives. I have already stated which I consider to be the best system at present developed, and as I have no interest whatever in that or in any other white lead process, any opinion I may express may be considered as disinterested and impartial. But whichever process may be selected, it should be, and doubtless will be, that which is calculated to confer the greatest benefit on the largest number.

A NEW THEORY OF DYEING.

It is well known that two theories have been maintained in explanation of the process of dyeing. According to the one—the so-called mechanical view—the process is a simple absorption, similar to that by which animal charcoal takes up gases and liquids and retains them in its pores. The other theory traces the phenomena of dyeing to definite combinations. Neither of the above theories is perfectly satisfactory. In consequence, M. Witt has put forward a theory in which he assimilates tinctorial operations to the phenomena of solution, or, in other words, to combination in indefinite proportions. He maintains that the coloring matter is dissolved in the fiber, which becomes dyed only if its affinity for the coloring matter is greater than that of the previous solvent. Thus, wool is dyed by magenta dissolved in water, but is not dyed if the color is dissolved in pure alcohol. If the solvent powers of the fiber and of the water are approximately equal, there is established a kind of equilibrium, and the dye bath does not become completely exhausted. If the solvent power of the fiber is less than that of the water, there is no dyeing. In this case the solvent power of the water may be decreased by adding sodium chloride or sulphate, etc. Or the solvent power of the fiber may be heightened, *e. g.*, by chloring wool, or by depositing sulphur upon it, or by mercerizing cotton.—*E. Noelting, in Revue des Sciences.*

GLYCIN.*

GLYCIN appears to be identical with *p.* oxy-phenyl-glycocoll, or para-oxy-phenyl-amido-acetic acid, with the formula—

$$C_6H_4\left\{\begin{array}{l}OH\\ NH,\ CH_2,\ COOH,\end{array}\right.$$

and is prepared, according to Vater, by the action of chloro-acetic acid upon para-amidophenol. It is therefore a chloro-acetate of para-amidophenol.

The sample I have is a light cream-colored granular powder, not altering readily in the air. It is not very soluble in water or in alcohol, but dissolves easily by the addition of caustic alkalies or their carbonates. The watery solution has a strongly acid reaction, but it is quite colorless. Alkaline solutions take a yellow tint, which disappears on the addition of sodium sulphite.

It is easily soluble in dilute nitric, sulphuric and hydrochloric acids, the solutions being quite clear and colorless. It is not so readily soluble in weak bromine water, but the solution becomes colorless. Nitrate of silver first turns the glycin solution a turbid, dirty greenish-black, but it afterward takes a violet tint, like slightly darkened chloride, and silver is precipitated, but not in the bright metallic form distinctive of metol. The same change takes place if the glycin solution be acidified with nitric acid before the addition of the silver salt; the silver precipitates and leaves a clear solution of a beautiful purple color. With a solution of glycin made alkaline with potash, nitrate of silver gave at once a thick brownish precipitate.

The manufacturer recommends two solutions for developing, according as the negatives are required to be soft and detailed, or hard and dense, and glycin is said to be especially suitable for reproductions of all kinds, photomicrography, etc. The formula for the first developer is:

1.

A.	Glycin	4	parts.
	Potash	1·5	"
	Sodium sulphite (crystals)	12	"
	Water	100	"
B.	Potash	10	"
	Water	100	"

For use, one part of A is mixed with two parts B.

Heat is required to dissolve solution A; but I find that, on standing, the salts have crystallized out in very pretty, thin, long hexagonal plates.

The second developer, for dense negatives, is as follows:

2.

Glycin	5	parts.
Potash	25	"
Sodium sulphite (crystals)	25	"
Water	100	"

diluted for use with three parts of water.

In preparing this, it is well to first dissolve the potash in the water, then the glycin, and add the sulphite. The solution is nearly colorless, or a dirty white, and does not readily change by keeping, either in color or in its developing power. I have not yet ascertained its full keeping powers.

Both of these formulæ give powerful and effective developers, yielding images of great density and brilliance, with clear shadows and perfect freedom from stain. Like other para-amidophenol developers, they require good exposure, and the density depends a good deal upon the length of time the plate is left in the solution, as is also the case with ferrous oxalate and the sulpho-pyrogallol developers. The action of glycin is slow compared with amidol and metol, but not inconveniently so, and there is not the same tendency to a general veiling over the image.

I find both developers quite suitable for ordinary landscape work, the first formula being, perhaps, the better, while, for copying, the second is more suitable. They also work very well with orthochromatic plates. I have not yet tried them for instantaneous work, but with a suitable very rapid plate and a large aperture of a quick-acting lens, they would probably answer. Several plates can be developed in a batch of developer without any marked change in it. The stability of the glycin, both dry and in solution, the density and clearness with which it works, and the latitude that appears to be permissible in exposure, seem likely to give it a very great advantage over para-amidophenol hydrochlorate and other new developers lately introduced. Largely diluted, it would probably be an excellent developer for lantern slides or for bromide paper.

A voltametric examination of the developer, made up according to formula 2, shows that it evolves hydrogen more vigorously than any other developer I have yet tried, and this would appear to favor the hypothesis that developing power is dependent, other conditions being suitable, on capacity for evolving hydrogen.

The dilute solution, made up in the above proportions, contained:

Glycin	1·25	parts.
Potash (anhydrous carbonate)	6·25	"
Sodium sulphite (crystals)	6·25	"
Water	100·00	"

This solution was first electrolyzed in the tube voltameter, described in a previous paper, with platinum electrodes, using, as before, a battery of four gravity cells, the current being 280 milliamperes, with a pressure of 4·2 volts, the resistance of the galvanometer being one ohm. The current through the voltameter at starting was 80 milliamperes, with a pressure of 3·2 volts, and in twenty minutes it had decreased to about 75 milliamperes and 3·15 volts. At starting, the solution in the tubes and the outer vessel was quite clear and colorless, the temperature about 72·5° Fah. When the current was turned on the evolution of hydrogen was very brisk, and the yield was, in five minutes, 2·5 c. c.; in ten minutes, 5·4 c. c.; and, in fifteen minutes, 7·6 c. c.

This corresponds very closely with the results obtained from an ordinary ferrous-oxalate developer containing four drops of a 10 per cent. solution of potassium bromide to 120 c. c. or about one drop to the ounce. In this case 5 c. c. of hydrogen were evolved in ten minutes, the current, with the same four-cell battery and voltameter, being about 75 milliamperes, with a pressure of 3·25 volts.

The solution in the oxygen tube turned a bright yellow, and the anode was surrounded by a dense layer of yellow solution. The general body of the solution in the outer vessel did not change color, nor did that in the hydrogen tube. At the end when the oxygen tube was removed and the solution in it mixed with the remainder, the whole was a bright yellow with a slight blue fluorescence.

With silver electrodes, the evolution of hydrogen was not so brisk, possibly owing to the immediate formation of a film of oxide on the anode.

With the same battery the current through the voltameter at starting was about 80 milliamperes with a pressure of 2·7 volts, and in twenty minutes it decreased to 75 milliamperes with 2·5 volts. The yield of hydrogen was, in five minutes, 2·2 c. c.; in ten minutes, 4·5 c. c.; and in twenty minutes, 9·3 c. c.

The anode was covered with a flaky deposit of silver oxide (?), and ribbon-like streams of a turbid yellowish solution were given off above and below the anode plate. As in the case of the platinum electrodes, the color of the solution in the outer vessel was not much changed; and when the solutions were mixed at the end, the mixture was slightly turbid and not such a bright yellow, but it was also fluorescent.

Dr. Eder, who reports on glycin in the *Photographische Correspondenz* for October, 1892, speaks highly of it, and gives a formula for a glycin-soda developer as follows:

Glycin	3	parts.
Sodium sulphite	15	"
Crystallized soda	22	"
Water	200	"

The solution can be used at once, and keeps unchanged for a long time in closed bottles. It gives clear and soft negatives, and, by lessening the quantity of soda or diluting the solution, the negatives will be more transparent. By adding bromide of potassium, even decided over-exposure can be remedied.

Baron von Hubl has found glycin a very valuable developer for collodion-emulsion plates when made up according to formula 1, diminishing the water to 80 if greater intensity is required, or mixing one part of solution A with three to five parts of B, or diluting the normal developer if less density is required. He says that this developer gives, with collodion-emulsion plates, perfectly clear shadows, a good and very compact deposit, rich half tones, and a surprisingly beautiful gradation. This agrees with my own experience of para-amidophenol hydrochlorate as a developer for collodio-bromide emulsion plates.—COLONEL J. WATERHOUSE, I.S.C., Assistant Surveyor-General of India.

* Journal of the Photographic Society of India.

AT a recent meeting at Hanover, of the Brunswick-Hanoverian Branch Union for the manufacture of beetroot sugar, some interesting remarks were made on a new substance called "valzin," which is expected to entirely supplant saccharine, and which may create a not unimportant competition with the sugar industry generally. This new substance was discovered by the Berlin chemist Blau, and is now being manufactured by Riedel, of Berlin, according to a patented process. It is about 200 times sweeter than sugar, but does not possess some unpleasant qualities said to belong to saccharine.

UTILIZATION OF THE SUB-PRODUCTS OF DISTILLERIES.

The utilization of sub-products in general is a question which for a number of years has received numerous applications and which is constantly occupying the mind of manufacturers. We are going to occupy ourselves especially with the use of the sub-products of grain distilleries by the processes studied as long ago as 1888, and presented in 1889 by Messrs. G. Boulet-Donnard and Contamine of Bapeaume-lez-Rouen at the Universal Exposition.

In 1888 these gentlemen, distillers of grains at Bapeaume-lez-Rouen, conceived the idea of employing the residues derived from the saccharification of grains by acid for the extraction therefrom of oily substances. To this effect they had Mr. Matter, proprietor of the Powell establishments at Rouen, construct some apparatus for them.

Later on, in February, 1891, some important modifications, indicated by practice, were introduced into the apparatus that permitted of increasing the results obtained in notable proportions.

Without entering into the details of the various transformations of the apparatus (the principle of the process not having been modified), we propose to examine both the process and the apparatus now in use. The principle that the inventors took as a basis is as follows:

Being given Indian corn cake derived from rough-ground grain that has undergone saccharification by acid and under pressure, the acid juices having been separated by filter presses from the unattacked solid substances, these cakes are brought to the state of granules, and the product is treated with gasoline, boiling between 70° and 90°. In these conditions the oily substances contained in the grain and not attacked by acid, if the saccharification treatment has been well performed, dissolve in the gasoline. This latter is afterward separated from the oily substances, and recovered by distillation.

Messrs. Boulet-Donnard and Condamine make use of the following apparatus:

1. An evaporating apparatus for drying the solid substances in a vacuum.
2. A double exhaustion apparatus.

Evaporating Apparatus.—The cakes on coming from the filter press contain about 50 per cent. of water. By means of a very simple granulating apparatus, formed of a horizontal screw with a very wide pitch, moving in a closed chamber and forcing the material to pass through a sort of die plate consisting of a disk provided with apertures and in front of which move four knives, placed crosswise, the material is converted into granules about one centimeter in length and two or three millimeters in diameter. If the cakes contain more than 50 per cent. of water, one has to fear an ulterior agglomeration of the granulated material; if, on the contrary, there were less water, one would risk breaking the granulating machine.

The granulated material is taken up by a bucket chain and emptied into a hopper placed above the drying apparatus.

This evaporator (Fig. 1) consists of a horizontal cast-iron cylinder 2·5 m. in diameter and 2·5 m. in length, which gives a capacity of 12 cubic meters.

At first, at each extremity of the cylinder there was a steam chamber which communicated by a bundle of tubes. After some experiments it was found that in a horizontal tube of a certain diameter and of a proportionate length, the steam introduced into one chamber (the other being closed) distributed itself in a few instants up to the end of the tube in driving out the air completely, so that a circulation of steam during the work can be established as well as if the tube were open at both extremities.

Through such experiments the inventors have been led to suppress the steam chamber to the right. The bundle of tubes, being set only into the vertical side of the left chamber, expands freely upon supports formed in the right plate, which then becomes a solid disk that closes the cylinder on this side and carries in its center the exhaust pipe.

The tubes are of copper, sixty-seven in number, and present a heating surface of 50 square meters. The interior of the cylinder and the exterior of the tubes are tinned in order to prevent the coloration of the oils by the metallic soaps formed by the attack of the copper or iron by the oleic acids.

The steam, expanded to 2 kilogrammes, is admitted through the axis of the hollow journal to the left. This latter is divided into two parts throughout its length by a partition which thus forms two conduits, one of which, F, serves for the admission of the steam, and the other, L, for the exit of the water of condensation.

The steam, on entering the chamber, spreads through the tubes and condenses therein, and the water of condensation, falling back into this chamber, is emptied, through a radial portion, into the conduit, L, of the hollow journal. Thence, the water goes to an automatic purge cock.

The entire cylinder, carried by its axis upon two bearings, can be set in motion and made to revolve at a velocity of from 3 to 5 revolutions per minute. To this effect around the steam chamber there is a crown wheel actuated by a pinion keyed upon a shaft that receives its rotary motion from any source whatever. In order to diminish the loss of heat, the cylinder is surrounded with a jacket.

For charging the apparatus there are two man-holes, which, as soon as the charging is effected, are closed. In order to obtain a more rapid evaporation, and at a lower temperature, the inventors use a vacuum pump connected with the apparatus by a hollow journal and a pipe of large diameter, O, which receives at a certain point the cold water injection pipe that serves for condensation.

After the apparatus is charged, the vacuum pump is set in operation, and the steam is turned on. The evaporation begins then at a temperature corresponding to the pressure in the cylinder. The apparatus is then set in operation in order to renew the heating surfaces and favor the evaporation.

In order to keep track of the progress of the work, thermometers and manometers are arranged upon the apparatus. Moreover, it is possible to take out a sample of the material by means of a special sound that prevents the entrance of air.

The ordinary charge is 2,500 kilogrammes of material containing 50 per cent. of water, and which in three hours is brought to a state in which it contains but 16 or 18 per cent. Two hundred or more gallons of water are thus removed at an output of 100 kilogrammes of steam per 95 kilogrammes of water vaporized, the total output of coal being 142 kilogrammes—motive power excepted.

In this way, there is obtained a porous material upon which the solvents can act very efficaciously to extract the oil therefrom. This substance is emptied into wagons that carry it to a special building in which the extraction apparatus are installed.

The evaporating apparatus just described has received still other applications, such as the drying of brewery dregs and dregs of malt distilleries. There is under study at present in Paris the use of a material for feeding horses which is made by drying potatoes in slices.

It is necessary to point out, too, as an interesting application of this apparatus, the use of it for drying wheat. Some experiments made with the co-operation of one of the largest millers of Beauce have shown that, by the use of this apparatus, it is possible to effect the cleaning of the grain by washing with water—a treatment which is more perfect than the cleaning of it in a dry state by grain separators. From these experiments, there has resulted another point in favor of the system adopted, which is as follows: grain washed and dried in the evaporator, put to germinate comparatively with natural grain not treated, has not only germinated a day sooner, but more regularly.

Double Exhaustion Apparatus.—The dry material is emptied from the wagons by a bucket chain that carries it up to the second story, in order that it may be distributed to the exhaustion apparatus (Fig. 2). These apparatus are two in number. Each consists of two boilers, A A', situated on the ground floor. These boilers are 2·5 m. in diameter and 2·5 in height. In the first story and exactly over each boiler is the exhaustion apparatus, B B', properly so called, consisting of a cylinder 1·2 m. in diameter and 3·1 in height. The upper part of each extractor is connected with the corresponding boiler by two strong copper pipes, E E'. At the upper part of the extractor there is also a large flat worm capable of receiving either steam or cold water through the simple maneuver of cocks.

The lower part of the extractors communicates, through piping and a worm, with the boilers. A second piping, branched upon the first, communicates with a second worm, smaller than the first, and interior to it, serving to condense the traces of gasoline remaining after the exhaustion of the charge, and receiving such condensation in a special reservoir, M. The lower boilers are heated by steam worms and can be supplied with water by a special piping. The boilers are emptied by means of cocks, O and O'.

The extractors being charged, let us suppose that, in the boiler, A, we have, due to a preceding operation, water and a mixture of oil and gasoline, the boiler, A', being empty. The cocks, F, H and I, are then opened, and the cocks, F', H' and I', are closed. The steam cock, S, being open, the boiler, A, is heated. The gasoline begins to distill and goes through the two lateral pipes, E and E,' to the upper part of the extractor, B, where it meets the worm cooled by a current of water. The gasoline condenses and falls warm upon the material to be exhausted.

The oil carried along by the gasoline passes into the worm and thence into the boiler, A'. Thermometers placed at different points of the passage of the gasoline permit of taking account of the progress of the operation. When the thermometer placed upon the upright pipes, E, exceeds 85°, warning is given that there is no longer any gasoline in the boiler, A, and one can be assured that the material is perfectly exhausted if care has been taken to put in a sufficient quantity of gasoline to dissolve the oily material. It is then necessary to drive off the excess of solvent contained in the extractor and impregnating the exhausted material. To this effect the heat is increased in A so as to exceed 100°. The water then begins to boil and the steam disengaged carries along the last traces of gasoline contained in the oil of the preceding operation. The steam, following the same route as the vapor of gasoline, reaches the upper worm, in which the cold water has been replaced by steam. In its passage through this worm, the steam disengaged from A becomes superheated before traversing the exhausted mass. It then drives before it the excess of gasoline impregnating the exhausted mass, and passing through the worm, G, rejoins the gasoline and dissolved oil collected in the boiler, A'. When the thermometer placed at the entrance of the worm marks 100°, one may be sure that the exhausted mass is free from gasoline, and it is then possible to proceed to the emptying of the apparatus and to the charging of it for a new operation.

During the operation, the air of A' has ascended through the lateral pipes, E', has traversed the raw material of the extractor, B', and, through I, has entered the second worm, wherein are condensed the traces of gasoline carried along.

Through this last arrangement it has been found possible to reduce the loss of solvent by at least 1-10 per cent. of the weight of the material treated. According to the inventors, such loss would be due to the probable dissociation of the gasoline during the distillation. In support of this opinion, they have found that, despite the power of the refrigeratories, there is obtained at every operation a certain quantity of incondensable gas escaping with the air.

The charge of each extractor is 2,400 kilogrammes. The operation lasts eight hours, and requires a consumption of steam of 75 kilogrammes per 100 kilogrammes of material treated, with a consumption of coal of about 250 kilogrammes.

The material is so thoroughly exhausted that but 5 per cent. (in weight) of oil is left, and the quantity of solvent employed is from 2,200 to 2,500 kilogrammes. The oil obtained is very limpid and can be delivered directly to commerce.

As for the exhausted material, that may still be used for the feeding of cattle, notwithstanding its having been submitted to a temperature of over 100° in the extractor.

The advantage of this process over that of presses is well demonstrated by the fact that in the apparatus for the extraction of oil by pressure it is impossible to extract more than 18 or 20 per cent. of oil, by weight, from the materials operated upon. As these materials contain from 30 to 35 per cent. of oil, it will be seen that 12 or 15 per cent. is left in the residue. In the

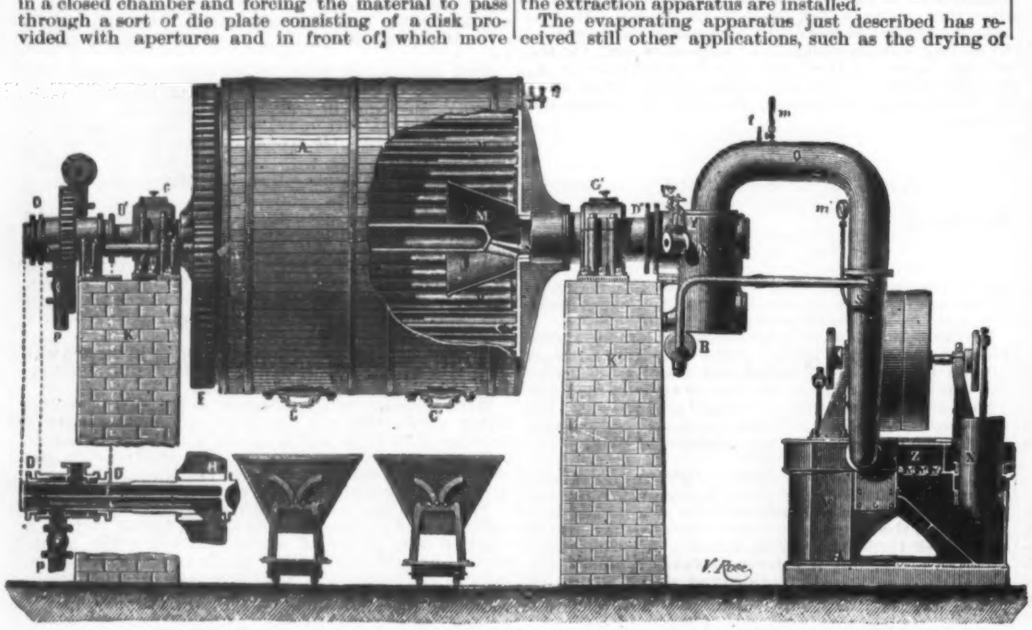


Fig. 1.—EVAPORATING APPARATUS FOR DRYING SOLID SUBSTANCES IN A VACUUM.

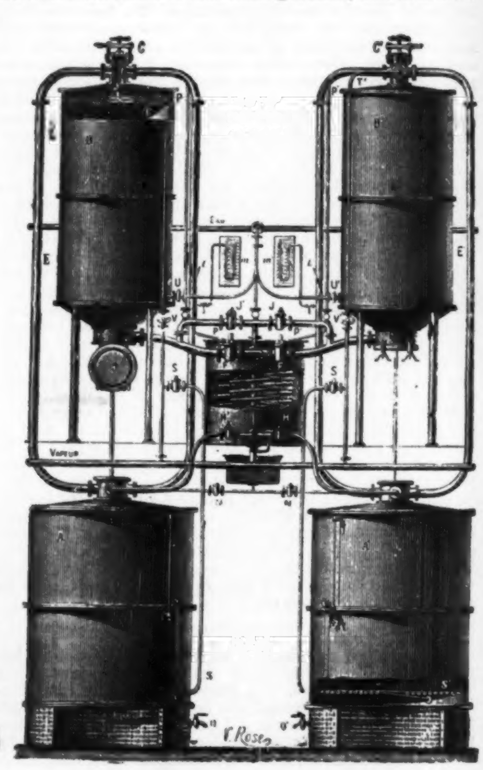


Fig. 2.—DOUBLE EXHAUSTION APPARATUS.

process just described the oil is extracted to within about ½ per cent.

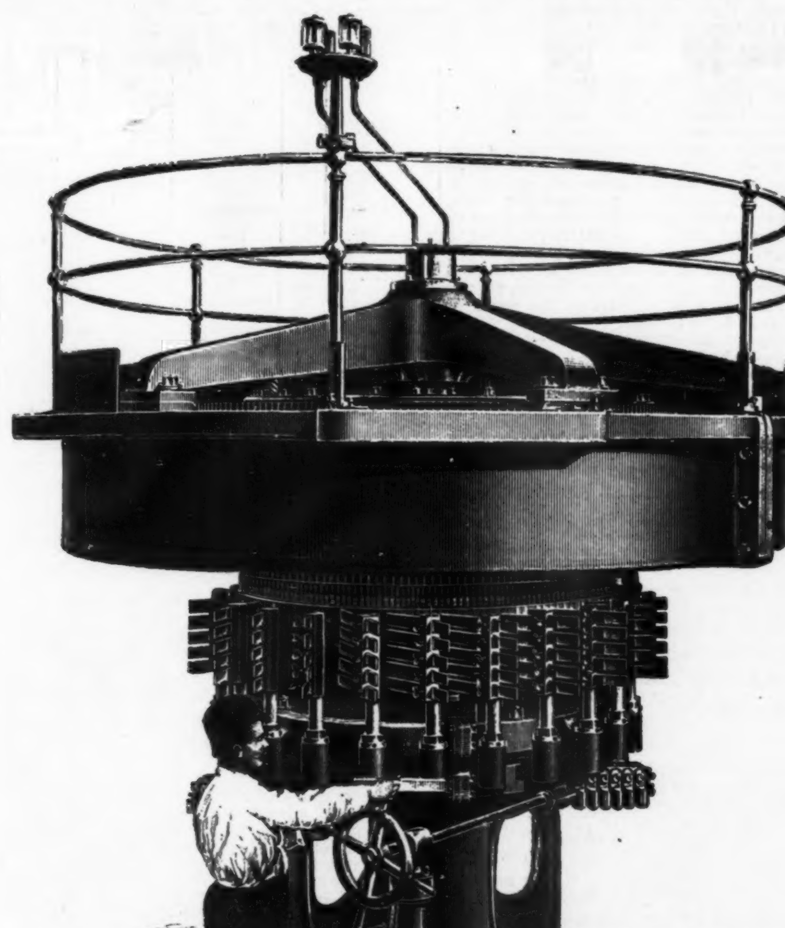
The installation made in the inventors' works at Bapeaume-lez-Rouen has been in operation since November, 1889. It comprises an evaporator that treats 16,000 kilogrammes of material per day, and two double exhaustion apparatus that produce 2,760 kilogrammes of oil per day. In the first month of the application of the process 200,000 kilogrammes of cake were treated and 60,000 kilogrammes of oil were obtained.—*Le Genie Civil.*

A VERTICAL DYNAMO.

THE engraving represents a general view of a vertical dynamo constructed by the Maschinenfabrik Oerlikon, Oerlikon, for the Aluminum Industrie Actiengesellschaft, Neuhausen, Switzerland. The dynamo has an output of 400 kilowatts, and is coupled directly to the vertical turbine shaft. The star-like bracket on top of the magnet frame contains the top bearing of the dynamo shaft; the magnet has 24 radial inward pole pieces, the whole being cast of iron and supported by heavy iron structures, not shown in the engraving. The dynamo shaft carries the armature and the commutator, a total weight of revolving material of about 12 tons. The brushes, 120 in number, can be moved within certain limits by means of a hand wheel. The magnetic proportions are such that there is but very little shifting of the brushes at varying loads. The machines are shunt wound and self-exciting.

The plant at the works of the Aluminum Industrie Actiengesellschaft comprises one of the finest electrical installations in existence, which utilizes the power generated by the celebrated waterfalls of the Rhine. Up to the present dynamos of a total horse power of upward of 2,000 have been in operation. The additions to this plant, comprising four generators similar to that illustrated, and designed to give 7,500 amperes at 55 volts and to run at 150 revolutions per minute, will give an aggregate capacity to the whole plant of 3,900 h. p.

The turbines for driving the dynamos have been constructed by Messrs. Escher, Wyss & Co., Zurich, and are provided with a device for hydraulically counterbalancing the weight of the moving parts, thus minimizing the pressure on the bottom bearing.—*Industries.*



IMPROVED VERTICAL DYNAMO.

AN ELECTRIC FLOOR AND DECK PLANER.

THE use of electricity for transmitting power has been steadily increasing during the last few years. Not only is it often found better than mechanical transmission, but in many cases it enables mechanical power to be applied to work where, without electricity, it would be quite impracticable to use anything but hand power. One of the latest machines of the latter kind is an electric deck planer, invented and patented by Mr. Malcolm Sutherland, electrical engineer to Messrs. W. Denny & Brothers, the well known shipbuilders of Dumbarton. The illustration shows one made by that firm, and used by them for planing the decks of the ships they build. It is so simple in construction that very little explanation is necessary.


AN ELECTRIC FLOOR AND DECK PLANER.

It resembles a lawn mower in form and is handled in the same way, and with as much ease. A steel base plate is mounted on rollers, and on the underside of this the revolving cutter is fixed. The electric motor is placed on top, and is geared to the cutter by means of toothed wheels. The latter is one of Rawlin's spiral cutters, and revolves at a speed of 3,000 revolutions per minute, the motor having a speed of 2,000 per minute. The hind rollers which follow in the cut are fitted with eccentric journals, so that by moving a lever they can be raised or lowered, and the depth of cut nicely adjusted. It does very good work, is faster than hand planing, and relieves the men of a very disagreeable job, as the planing of decks by hand involves kneeling or sitting in a very uncomfortable position. Current is supplied to the motor by means of a twin flexible lead, and the whole machine is of a very compact and portable nature.—*Electrical Review.*

JETTY HARBORS OF THE PACIFIC COAST.

AT the last meeting of the American Society of Civil Engineers, Capt. Thos. W. Symons, U. S. Engineers, submitted a paper on the above subject. The Pacific coast is generally high and rocky, and has few good harbors. The shore is formed largely of sands and easily moved. From the southern limit of California to the northern limit of Washington, the length of shore line is 3,120 miles, of which California possesses 1,097, Oregon 285, and Washington 1,738 miles, the latter including that of the islands in Washington and Puget Sounds. The slope of the ocean bottom near the land is about four fathoms per mile. On the Washington coast 100 fathoms depth is reached at about 20 miles from shore; on the Oregon coast at 10 miles, and along California at 6 miles. A depth of 1,500 fathoms is reached at about 60 miles from shore, giving an average slope of 25 fathoms per mile.

The main ocean current off the coast is from the northwest, producing a reflex eddy current to the northward along the coast. Along some parts of the coast, but not all, this is continuous throughout the year. The prevailing summer winds are from the north and northwest, and the severe winter winds from the south and southwest. These cause currents near the shore in the same direction, extending seaward 16 to 50 miles, of 1 to 1½ miles per hour. The tides increase in range from 3·7 feet at San Diego, in the south, to 6·2 feet at the mouth of the Columbia. At the head of Budd's Inlet the range of tides reaches 18 to 20 feet.

The marked peculiarity of these tides is that in each lunar day there are two high and two low waters, which are generally unequal in height and different in interval. They are called "lower low," "higher low," etc. From lower low the tide rises to the lower of the two high waters, then falls to a higher low water, rises to a higher high water, and then falls to the lower low water. Sometimes there is little difference between the "lower high" and "higher low," or practically no change for hours. The datum plane is a mean of the "lower low," and is about one foot below that of mean low water.

The rock along the coast is mostly sandstone, that in the projecting points being the harder. In addition to this source of sand, the coast range of mountains at about 20 miles from shore consists mostly of soft sandstone. The visible sand along the coast consists of dunes entirely destitute of vegetation; of others covered with drift wood, upon which a feeble growth exists, and large areas are exposed at low tide. A careful study of the movement of the sands must be made in every locality where improvements are projected. In some places, as at Coos bay, for example, the sand moves in a cycle, being first washed up on the spit, then dried and carried by the winds into the bay. The tidal currents sweep it out to sea and the waves throw it back on the bar, to again begin the round. The control of this movement by plant growth, while yet experimental, bids fair to accomplish much good.

Where the sand is heavy and coarse, the scouring of a channel through a bar is slow; but, on the contrary, when once formed, it is more stable than where the sand is light. The immense forests of the interior furnish great quantities of drift material, so that the whole North Pacific coast is lined with it. Logs four to six feet diameter and 100 feet long are found intermingled with stumps and other forest debris. At the mouth of a drift-bearing stream, special precautions have to be taken to prevent injury to working in progress. At Port Orford, in Oregon, and San Pedro, in California, harbors are proposed for deep ships, to be formed by breakwaters. Jetties have been, and are, under construction at other points.

The first jetty to be constructed on the Pacific coast was at Yaquina Bay, a narrow estuary, 20 miles long, and 115 miles south of the Columbia River; its tidal area is five square miles and its drainage area 262 square miles. The average height of tide is seven feet and the maximum range 11 feet. The mean outflow of tide at ebb is 32,000 cubic feet per second, and the channel, carrying seven feet at low tide across the bar, was constantly shifting in position. A quarter of a mile out from the bar is a reef of rocks which broke the swell and acted as a breakwater. The depth inside was four to five fathoms. Examinations by boring showed that the maximum depth to be expected by scour was 18 feet. The heavy waves of winter assume a motion of translation at depths of eight to ten fathoms, and carry great masses of sand shoreward.

The plan of improvement adopted was to construct

two jetties 2,300 feet apart at the harbor throat and converging to 1,000 feet at deep water, the north one being 3,600 feet and the south one 2,300 feet long. These were so located as to deflect the channel to the south of the reef. The jetties are rubble mounds reaching to high water. The south jetty was built on brush mattresses four feet thick, resting on sand, and the north one on the rockbed. A tramway was carried on a trestle, and an interesting feature was the use of a revolving pile driver, which could drive piles 15 feet in advance. The mattresses were of brush fascines and pole bound together, and were constructed underneath the tramway tracks and around the piles, loaded with stone and sunk. The sinking of piles in sand is now done entirely by the hydraulic method. The total cost of the jetties was about $90 per lineal foot.

The result reached has been to double the low water depth on the bar and maintain it in a good location; the least depth in a year has been 14 to 15 feet. Outside of the channel, against the jetties, great quantities of sand have accumulated. It was only when both jetties were completed that permanency ensued in the channel, as before the north jetty was completed the channel wandered greatly.

At the mouth of the Columbia River the work is about completed, and the largest vessels can now sail in and out easily. The bar extends in a curve convex to the sea, with its vertex four miles out. Inside, there were shoals and sand islands among which the channel ran, with a depth on the bar of 19 to 27 feet. The estimated mean tidal discharge is 1,000,000 cubic feet per second. The fresh water discharge from the river is 90,000 feet at low water and 600,000 when the river is high. A jetty, four and three-fourths miles long, consisting of a rubble mound built on mattresses three feet thick and 40 feet wide, was built up to low water, to concentrate the water of the river within a moderate width, and discharge it as a unit to the sea. The result has been to increase the depth at low water to 29 feet in a single channel, thus far permanent, which is 1,300 feet wide; at 27 feet depth it is one mile wide. The jetty has cost $83 per lineal foot. The jetty, while called a low tide jetty, has really been built four feet higher, to allow for subsidence.

Other works were described, including Wilmington Harbor, Cal., Coos Bay, Humboldt Bay and Coquille River. The paper went into details of construction, the methods of carrying on the work, the use of quoins to prevent undermining, and the relative advantages of low and high jetties, the latter being considered generally preferable.

[From Engineering, London.]

THE BERNE COMPRESSED AIR TRAMWAY.*

By C. S. Du Riche Preller, M.A., Ph.D., Assoc. M. Inst. C.E.

Line and Equipment (Figs. 1 and 2, p. 14426 *ante*).—The main line traverses the town of Berne from east to west, and measures 3 kilometers, or 2 miles, within which, being a single line, it has eight passing places about 60 meters, or 66 yards, in length each. The curves, whose minimum radius is 50 meters or 2·5 chains on the main line and 30 meters or 1·5 chain in passing places and terminal sidings, represent 27 per cent of the whole length, the steepest grade, as already mentioned, being 5·2 per cent. The permanent way consists of M grooved "Demerbe" rails and automatic turnouts, without transverse sleepers or longitudinal bearings. The rails rest direct on a gravel foundation or on concrete where the soil is loose, and are kept to gauge by flat iron ties 2 meters apart. It is surprising that this type of tramway rail should have been adopted, seeing that it is everywhere being replaced by the Phœnix girder rail or the Harmann or the Marsillon system (double Vignoles rails). The inherent defects of weakness and of insufficient depth of groove of the Demerbe rail go a long way to account for the considerable extra resistance which the cars at Berne have to overcome, more especially in curves, where the grooved rail, moreover, precludes the gauge being widened. As the line is being laid in the center of the paved roadway, the outer rail is not raised, except in a few places, where the super-elevation is 2·5 centimeters, or 1 in. The width of excavation for laying the permanent way is 2 meters, or 6·56 ft., to a depth of 25 centimeters, or 10 in. The weight of the rails is 33 kilogrammes, that of the permanent way, including fastenings, 71 kilogrammes per lineal meter, or 66 lb. and 142 lb. per lineal yard respectively. The extensions will be laid on one side of the road with heavy, deep grooved Phœnix girder rails, although on suburban roads single Vignoles rails, with guard rails in sharp curves and at cross roads, would be at once more efficient for adhesion, and more economical, seeing that the present cost of Phœnix permanent way is, including laying, 26 fr. per meter lineal (19s. per yard), as against only 20 fr. per meter (15s. per yard) of line laid with 40 lb. to 44 lb. Vignoles rails. Pending the erection of the requisite new compressed air plant, the suburban extensions are to be worked with 17 ton steam locomotives.

The total cost of the main line, including turbine transmission, compressing, accumulator, and loading stations, car shed, repair shop, offices, passenger huts at stopping places, and 10 motor cars (15,000 fr. each complete), was 460,000 fr. or £18,400, equal to 153,000 fr. per kilometer, or £9,792 per mile.

The works of the line were carried out under contract by M. Anselmier, of Berne, while the compressed air plant and motor cars were supplied by the Berne Maschinen Fabrik, from the designs of M. Mekarski, of Paris. The inadequacy of the calculations and estimates in some important particulars, in relation more especially to the supply of compressed air and to the tractive force of the motor cars, entailed during the execution of the works a good many modifications and consequent delays, to which reference has already been made.

Working.—Besides the manager and the foreman of the loading station, the staff of the line is composed of 40 men, or 20 men per mile, this high rate being accounted for not only by the present short working length, but by the new Swiss regulations for Sunday rest, which involve an increase of the staff by one-third. The wages of the drivers and guards are 4·50 fr. and 4 fr. (3s. 6d. and 3s. 2d.) respectively per day, both for their working and their 52 holidays per annum. For the present 10 minute service seven motor cars are required, of which six are constantly on the line and two ready loaded in the depot, while the remaining two cars are kept as reserve or undergoing repair. One journey over the line takes 20 minutes, equal to a mean speed of 9 kilometers or 6 miles per hour, including five stoppages, the speed between the stopping places varying from 11 to 15 kilometers, or 7 to 10 miles per hour.

The number of single journeys made per day of 14 working hours is 160, equal to about 500 car kilometers or 300 car miles, the mean number of passengers in the year 1891 being 3,140 per day, or about 20 per car journey. The carrying capacity of 28 passengers per car was therefore utilized at the mean rate of about 60 per cent. The population of the city of Berne being 50,000, the traffic on the line was equal to 23 passengers per head of population, which is a fair criterion for the first working year on similar tramways. The authorized fares are at the rate of 6·6 centimes per kilometer, or 1d. per mile, the gross earnings in 1891, which are greatly in excess of the orignal estimate, amounting to 40,634 fr. per kilometer, or £2,600 per mile, equal to £50 per mile per week. During the whole year the service was carried on with the greatest regularity, except during the severe frost in the winter of 1890-91, when it was occasionally interrupted, owing to the supply of compressed air failing, consequent upon ice forming in the old main pipe. This ice had to be dissolved by the pipe being embedded in hot sand. The removal of snow from the line after an exceptional fall was speedily effected by a salt trolley provided for the purpose. The working expenditure works out as follows:

—	Per Kilometer.	Per Mile.	Per Car Kilometer.	Per Car Mile.	Per Cent.
	fr.	£	cts.	d.	
Administration	2,706	173	4·85	0·74	8.3
Maintenance of line	1,210	77	2·15	0·33	3·7
Traffic	5,528	354	9·80	1·50	16·7
Motive power	21,698	1,389	38·35	5·87	66·0
Sundries	1,768	113	3·15	0·48	5·3
	32,910	2,106	58·30	8·92	100·0

Motive Power.

	Per Car Kilometer.	Per Car Mile.
	cts.	d.
Wages	19·05	2·93
Turbine power, £4 per horse power, oil, fuel	12·08	1·86
Maintenance and renewal of plant and motors	6·27	0·93
Sundries	0·95	0·15
	38·35	5·87

As the gross receipts were 70 cents per car kilometer or 10·7d. per car mile, the working expenses are equal to 83 per cent. of the former, and the net earnings of 6,904 fr. per kilometer or £431 per mile represent already in the first working a return of 4·4 per cent. on the capital cost of the undertaking. The expenditure on account of hydraulic primary motive power amounted to 8,000 fr., which, at the rate already mentioned, of 100 fr. per horse power per annum, is equal to 80 horse power. This power was used by three air pumps generally at work, two of which, at their full power of 35 horse power each, deliver 160 kilogrammes or 350 lb. of compressed air (about 45 kilogrammes per horse power) per hour each, while the third delivers from 50 to 100 kilogrammes or 110 lb. to 220 lb. per hour to make up the required total net supply (allowing 10 per cent. for loss in transmission) of 340 to 385 kilogrammes per hour, which varies according to the traffic, to the condition of the road, of weather, and to the more or less efficient working of the motors.

From the results of six official trial trips, of which the details were published at the time by M. A. Bertschinger, C.E., of the Federal Railway Department,* the writer has worked out the varying pressure and the mean consumption of air during a double journey per motor car as follows:

Storage Cylinders.	Working Battery		Reserve Battery	
	Atmospheres.	Pounds per Square Inch.	Atmospheres.	Pounds per Square Inch.
Pressure of air on starting	30	440	30	440
Pressure of air at end of up journey	12	176	18	260
Pressure of air at end of down journey	7	103	12	176
	kilos.	lb.		
Consumption of air during up journey	42	92	Total, 56 kilos. = 123 lb.	
Consumption of air during down journey	14	31		

This has been fully confirmed by the working experience of 1891, when the consumption of air per motor car and double journey was as follows:

Minimum	47 kilos. = 103 lb. = 8 kilos. per car kilom. = 28 lb. per car mile.
Maximum	70 kilos. = 154 lb. = 12 kilos. per car kilom. = 42 lb. per car mile.
Mean	56 kilos. = 123 lb. = 10 kilos. per car kilom. = 35 lb. per car mile.

The daily average of 500 car kilometers requires, therefore, from 5 to 6 tons of compressed air. The three pumps working at full power can deliver in 14 hours, 3 × 160 × 14 = 6,720 kilogrammes, or 6·7 tons, less 10 per cent. loss, or 6 tons at the loading station. It is seen that this supply barely suffices for the ordinary full 10 minute service, and provides no margin for increasing or doubling the service, unless the fourth pump were also working, or air was stored by night pumping in the six accumulators, whose total capacity of 7,500 liters or 7·5 tons is, however, equal to only 2·5 tons of air under a pressure of 30 atmospheres or 440 lb. per square inch.

Conclusion.—The principal advantage of the compressed air system for urban and suburban tramway traffic as worked at Berne consists in the pleasing appearance of the motor cars, if properly proportioned; in the absolutely smooth and noiseless motion; in the total absence of smoke, steam, or heat, of overhead or underground conductors, of the more or less grinding motion of most electric cars, and of the jerky motion to which underground cable traction is subject. On all these grounds the system has fully vindicated its claims as being preferable to any other so far known system of mechanical traction for street tramways. Its disadvantages, on the other hand, consist in the extremely delicate adjustment of the different parts of the system, in the comparatively small supply of air carried by one motor car, which necessitates the car returning to the depot for refilling after a run of only four miles or 40 minutes, although on the Nogent and Paris lines the cars, which are, moreover, larger, and carry the outside passengers on the top, run 7 miles, and the loading pressure is 45 atmospheres or 547 lb. per square inch, as against only 30 atmospheres at Berne. Longer distances in the same direction would involve either more powerful motors, a larger number of storage cylinders, and consequently heavier cars, or loading stations every four or seven miles; and in this respect the system is manifestly inferior to electric traction, which easily admits of a line of 10 to 15 miles in length being continuously fed from one central station without the loss of time and expense caused by reloading. The working expenditure at Berne was, in 1891, 8·6 centimes or 0·7d. per passenger, the gross receipts being 10·4 centimes or 1d. per passenger, so that lower fares than those charged, viz., 6·6 centimes per kilometer, or 1d. per mile, would not be remunerative. Moreover, the percentage of working expenditure can be kept within 83 per cent. only by the low cost of the primary hydraulic motive power. If, instead of by water power, the air pumps had to be driven by steam, the cost of primary motive would be increased, owing to the high cost of coal—32s. per ton in Switzerland. Nevertheless, for the extensions the company contemplates primary steam power, which is also used at Nantes and Nogent, and admits of the engines, the pumping accumulator, and loading station all being in one central station, thus admitting of a better organization, and compensating in part the extra cost by saving the expense and loss of power due to the turbine transmission and compressed air main of the present installation. It may, however, be averred that as primary power for such compressed air installations, gas engines actuated by town or Dowson gas might be more economical than steam. The cost of working the Berne line compares, as shown by the annexed table, with some other tramways worked under similar conditions by horse and mechanical traction for the year 1891. As is seen, both in the case of compressed air and of electric traction, the cost of working is considerably increased where steam, at a high cost of fuel, has to be used instead of hydraulic power. Given the latter, the cost of working by air is about the same as that by steam locomotives or steam cars; but over both of these last named, compressed air offers, at equal cost and for such short lines with constant traffic, certain advantages.*

1891.	Length of Line.	Motive Power.	Cost of Construction and Equipment.		Cost of Working.	
			Per Kilometer.	Per Mile.	Per Car Kilometer.	Per Car Mile.
	km.		fr.	£	cent.	d.
Geneva, city	14	Horse.	190,000	12,160	63	9·7
Zurich, city	9	"	124,000	7,940	38	5·8
Geneva, suburban	65	Steam locomotive.	100,000	6,400	43	6·6
Mulhouse, city	29	"	70,000	4,480	58	8·9
Montreux, suburban	11	Hydro-electric.	65,000	4,160	34	5·2
Florence, suburban	8	Steam-electric.	100,000	6,400	65	10·0
Tours, suburban	10	Steam cars.	60,000	3,840	56	8·6
Nogent (Paris), suburban	12	Steam-compressed air.	144,000	9,220	83	12·8
Berne, city	3	Hydro-compressed air.	153,000	9,790	58	8·9

THE LEASE OR TRIBUTE SYSTEM OF MINING.

The following is an abstract of a paper by Benjamin B. Lawrence, Denver, Col., presented at the Montreal meeting of the American Institute of Mining Engineers:

The lease system is the gradual result of the development of our larger producing mines throughout the State of Colorado. The operation of a mine, or group of mines, by corporations has been attended, in many cases, by disaster, owing to the difficulty of securing a day's work from the men employed in the mine, the loss entailed by careless mining and sorting of high-grade ores, and by lax or inefficient management on the part of superintendents and foremen.

Given, therefore, a mine that has been practically abandoned by its owners for the reasons given, but still possessing merit, the lessee appears on the ground and secures a lease for a year, or term of years, from the owner or owners, paying them a royalty upon the gross smelter or mill returns of the ore which he mines. In this way many of our abandoned mines have been reopened by the miner, who, with two or more of his associates, has been enabled by careful attention to obtain profitable results.

This procedure led to the leasing of portions of a mine to different lessees, the mine still remaining under the control of the owner or owners. The lease system is now largely in force in Clear Creek and Lake Counties, and, in order that its workings may be clearly understood, we will cite the instance of a well-known mine in Georgetown, Clear Creek County. This property is owned and operated by Mr. G. under the lease system, and his methods have proved so successful

* Continued from Supplement, No. 903, page 14426.

* "Schweiz. Bauzeitung," vol. xvi.

* A printer's error was made in the formula given for the cooling of air by expansion, at the top of column 2, page 14426 *ante*. The expression should read:

$$\frac{273 + \text{temp. } V_1}{273 + \text{temp. } V_2} = \left(\frac{V_2}{V_1}\right)^{0{\cdot}41}$$

that his example may be followed with profit by many other mines of this description.

The lessee applies for a lease, we will say, upon a block of ground in level "C." This block of ground is the extension of drift "C" for 100 feet, which he drives at his own expense, the owner furnishing the necessary supplies—powder, fuse and candles—the lessee paying for these and for hoisting the ore and dirt and all other necessary expenses incident to the handling of the ore. The terms of the lessee are that he should drive a level 100 feet, and have the privilege of back-stoping this ground to the level above. The royalty which he pays to the owner of the property depends upon what the ground immediately behind, above and below him has yielded, if it has been opened, and varies from 25 to 33⅓ per cent. Should the level have been contracted for and driven by the owner, and this 100 feet of back show ore in paying quantities, the lessee pays a royalty of from 33⅓ to 75 per cent. of the gross smelter returns.

By this method the owner develops his mine at little or no cost to himself, the lessee driving levels, sinking winzes, etc., in order that he may open stoping ground. It is evident that, under this method, the owner takes little or no risk, and is assured of profit if ore is found. The lessees are under full control of the foreman of the mine, and are subject to the same rules as would govern them if under day's pay.

By dividing a mine up into blocks of ground, varying from 50 to 100 feet in length by the distance between the levels, each lessee works his own particular block of ground, the ore being kept separate, and, when delivered on the dump, becomes the property of the lessor or owner of the mine. The ore is then shipped to the nearest sampling works and its value ascertained, the lessee paying the cost of the control sample.

The advantages of this system as applied to the mines of Clear Creek County, over the day's pay plan, may be briefly summarized as follows:

1. The mine once opened can be operated with a small working capital.

2. The percentage of profits received from the sale of ore are absolutely net, the lessee paying all costs of mining, hauling, etc.

3. As a lessee is interested directly in the ore which he mines, he will take care that none is lost, either in the mine or in sorting it. As the ore of this district will average at least $200 a ton, and many rich specimens are found, it also precludes the danger to all mine owners of the small peculations by employes.

4. Under the lease system the mine is not liable for lien.

5. The lessee is responsible to the owner of the mine for carelessness of any kind which may result in damage to the mine or accident to men working therein. Under day's pay the owner is responsible to his employes.

6. But little supervision of the men is necessary under ground. They will all do a day's work under the lease system, as they are working for themselves, and a man will work harder for himself than for any one else. The opportunities in a mine for shirking work are perfectly understood by both employer and employes.

7. Economy in the use of supplies of all kinds. Under day's pay a miner will use almost twice as much powder as under the lease system.

8. Miners will take great chances to find pay ore. Development will therefore cost little, as every miner working in a mine is interested in its product and the opening of new ground; he is familiar with the mine, and the owner has the benefit of his experience in finding ore, which may often baffle the keenest manager and foreman.

The system has proved an undoubted success in the leading mines of Clear Creek County, and is now being rapidly introduced into the other camps of the State, notably in Leadville and Aspen, as its working is capable of being so adjusted as to suit the character of the mine.

It is often necessary, should the mine be in poor ground, to encourage the lessee by what is known as allowance of footage, which means an allowance of, we will say, $2 a foot to drive a drift, which, under day's pay or contract, would cost $7 a foot, giving him the privilege of leasing the ground which he opens up. With ample working capital, given a non-productive mine which it is proposed to develop, it is advisable to open the property under contract, leasing the stoping only. The royalties, as has been stated, which rule in Clear Creek County, vary from 25 per cent. to 75 per cent. of the gross mill returns.

It is the popular belief that only those mines which have failed under corporate management are worked under this system, and also that in leasing a mine you are practically "gouging" or destroying it as a workable property. This belief is entirely erroneous, as this system is now applied to some of our best producing mines, and they can be kept in as good condition under the lease system as under day's pay or other plan. The men leasing blocks of ground in this way do not obtain any more privileges than if they were employed by day's pay. The system is recommended to the careful attention of all mine operators.

PROBLEMS OF MECHANICS.

AFTER passing his baccalaureate examinations, one knows very well the definition of a force or work and what mathematical formula connects those two quantities, but few students, we think, have an exact idea of the intimate relation that exists between the formulas and the phenomena that are daily observed. There is nothing more useful to those who make use of such formulas than to establish this connection. As long as the latter is not intimate, the formulas are devoid of meaning. It is unnecessary to say that we are not writing here for those who are acquainted with mechanics; but upon reflecting upon the very simple problems that we are going to treat of, *debutants* will, perhaps, have some of their notions fixed.

We shall, in the first place, recall two experiments that every one has performed or seen performed:

1. Let us strike a plate of copper with a small hammer, and without any effort we shall make an impression. Let us now press upon the plate with the head of the hammer and we shall not succeed in producing the least durable trace.

2. Let us put a one kilogramme weight into a scale pan, and throw into the other pan a piece of wood weighing 800 or 900 grammes. The beam will tilt, and if we remove the wood before the beam has regained its equilibrium, we might think that it weighed more than a kilogramme. This process is well known to merchants who are not over-scrupulous.

Has it not occurred to more than one of our young readers to ask himself the question: What is the pressure necessary to leave an impression upon a piece of copper? How is such pressure reached by a slight impact, while a powerful stress does not suffice to produce it? What is the weight that, thrown into a scale pan, will be momentarily balanced by a greater weight?

Let us take the definition of elementary mechanics: A work is equal to the product of a force by the extent of its travel. Besides, a force acting upon a body that it displaces communicates to it a live power exactly equal to the work of the force, and which can be destroyed only by an equal work acting in an opposite direction.

When we give a blow with a hammer we cause to act upon the head of the latter the force of gravity, to which we add a slight stress of the hand. Let us neglect this latter (which amounts to the same thing as granting that the hammer is heavier) and let us suppose that the head of the instrument weighs 100 grammes; then the hammer, falling say 30 centimeters, will have, on striking the plate of metal, a live power equivalent to 3,000 gramme centimeters, the term gramme here designating a weight.

If the hammer does not rebound, the entire work has been expended in the impact. Let us suppose that the impression left in the metal is 0·1 millimeter, then the mean stress necessary to arrest the motion of the hammer will be $\frac{3{,}000}{0{\cdot}1} = 30{,}000$ grammes, that is to say, 30 kilogrammes. The maximum stress is theoretically double, and, in the suppositions that we have just made, it is the weight that the head of the hammer must have to produce by simple pressure the impression that we have supposed. In the impact of very elastic bodies (spheres of steel, for example) the momentary impression does not subsist, but the bodies are violently separated from each other: their live power, entirely balanced in a very short travel, gives rise at the place of impact to an enormous pressure.

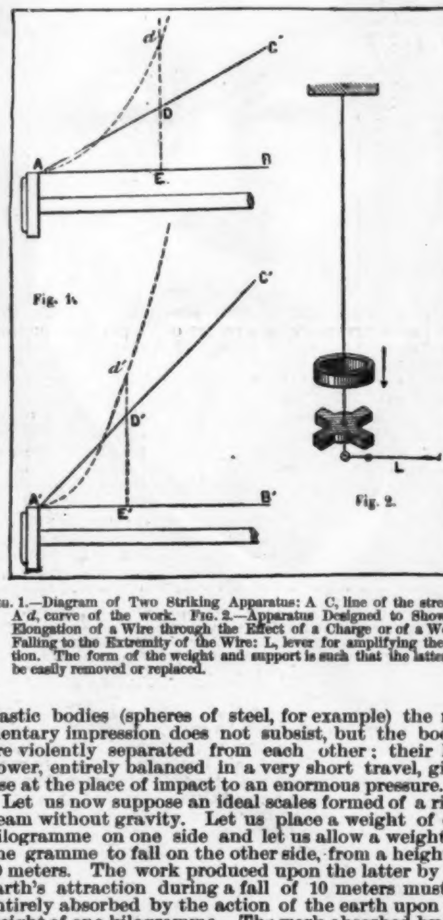


FIG. 1.—Diagram of Two Striking Apparatus: A C, line of the stresses; A d, curve of the work. FIG. 2.—Apparatus Designed to Show the Elongation of a Wire through the Effect of a Charge or of a Weight Falling to the Extremity of the Wire: L, lever for amplifying the motion. The form of the weight and support is such that the latter can be easily removed or replaced.

Let us now suppose an ideal scales formed of a rigid beam without gravity. Let us place a weight of one kilogramme on one side and let us allow a weight of one gramme to fall on the other side, from a height of 10 meters. The work produced upon the latter by the earth's attraction during a fall of 10 meters must be entirely absorbed by the action of the earth upon the weight of one kilogramme. The work absorbed by the small weight is 1,000 gramme centimeters, equivalent to one kilogramme centimeter. The extremity of the beam will therefore displace itself one centimeter, and then return to its first position. A real balance will doubtless undergo but a very small displacement, since the greater part of the work of the fall will be absorbed by a flexion of the beam.

With this question is connected the following: What is signified by the readings of the striking apparatus celebrated in casinos and at public fetes? We might be tempted to answer: "Absolutely nothing." Let us, in fact, analyze their mode of action:

The live power of a blow is absorbed by the flexion of a spring, and it may be so absorbed in numerous ways, all of which will give the same product of a mean stress by a displacement. In a graphic representation it is the product of the displacement by the sum of the stresses which must give a constant superficies.

Let us suppose two apparatus (Fig. 1), one of which has a travel double that of the other for the same maximum stress. The same work will be absorbed in the first for a length, l, with a maximum stress, f; in the second, by a maximum stress, $\sqrt{2}\ f$, at the end of a travel $\frac{l}{\sqrt{2}}$. The product is the same, but the reading of the apparatus varies in the ratio of 1 to $\sqrt{2}$. In Fig. 1, the ordinates of the line, A C, represent the stresses, and the superficies of the triangles, such as A D E, gives the total work for the travel, A E. Such work is represented also by the curve, A d. It will be seen that to the same work, d E, d' E', corresponds the reading D E or D' E', which is not the same in the two apparatus.

Another variable, independent of the live power of the first, is the mass whose motion is arrested by the spring. For the same velocity the effect is proportional to the mass, and if we wish to obtain an elevated reading, it is necessary to give the entire body a motion forward. The work of the legs and loins is then added to that of the arms.

Therefore, the measure of the blow of the first varies with the apparatus and with the striker for a same stress of the arm. It in nowise corresponds to the local effect of a real blow of the fist. It would not be difficult to construct an apparatus whose receiver was a pad, terminating in a steel rod centered upon an extremely resistant spring, of very slight amplitude, an elliptical spring, for example. The pad is held at a short distance from the latter by a weak spiral spring. The rod therefore reaches the elliptical spring with a certain velocity, and the impact occurs between two pieces of steel. The deformation is very feeble, the work is absorbed upon quite a short travel, and the reading is very elevated. By proper management there might doubtless be obtained fist blows corresponding to a static charge of several hundred kilogrammes.

School boys well know how to crack a nut by the following process: A medium or large-sized nut is laid upon a hard table, the forefinger of the left hand is placed upon the suture of the nut, and then a hard blow is given to the finger by the fist. The nut will be cracked almost to a certainty, and, moreover, the finger will in nowise be injured, much to the astonishment of those who try the experiment for the first time. What we have just said explains what occurs in this case.

The local effect is thus produced at will. Thus, when one jumps from a certain height, he reaches the ground upon the tip of his feet, and allows his legs to bend, in graduating the stress in such a way as to gently annul the velocity acquired. In the contrary case the shock received by the hips is very disagreeable. The live power has been annulled in the first case upon a long travel with a moderate stress, and, in the second, upon a very short distance with a great and sometimes dangerous stress. So, too, when a person receives in his arms a package of a certain weight thrown from a first story, it is necessary to guard against arresting it too abruptly. The arms must be stretched out as high as possible, and then, at the desired moment, they must give way gently. If need be, one will lean forward so as to make the loins participate in the work.

In this domain there is a fact that is paradoxical, but one that a very simple calculation proves the exactitude of. Let us suppose a wire suspended vertically and carrying at its lower extremity a small cross-shaped plate (Fig. 2). Let us allow a heavy ring to fall upon the latter. The height of the fall may possibly be such that the wire will break. Let us now charge the plate with a certain weight and begin the experiment with a wire identical with the first. If the wire, the weight, and the height of fall have been properly selected, the wire will resist perfectly.

We can, without any formula, get an idea of what occurs in this case. The live power of the weight that falls must be annulled by the stress exerted by the wire in elongating. If the latter is primitively charged, it undergoes a first static elongation, but, when the ring falls, the two masses take on together a velocity reduced in the ratio of the movable mass to the sum of the two. The live force is reduced in the same ratio and the additional elongation that results therefrom, added to that which already existed, may be less than that which is produced in the case of the wire not charged. For a static charge the breakage does not depend upon the length of the wire. For a fall, the chances of breakage are inversely proportional to the square root of such length. Another very instructive experiment is the following:

Let us suspend from the same beam two steel wires and two rubber threads of the same length. Let us charge a wire and a thread with equal increasing weights. The rubber will finally break. By means of the arrangement already described let us allow equal weights to fall from the same height upon the extremity of the other wire and rubber thread. By gradually increasing the height, we shall finally break one of the two. Which one? This time it will be the wire. With the wire and thread remaining as champions of the first match, we may perform the following experiment: Charge the wire and allow a weight to fall to the extremity of the rubber thread. The experiment will show that it is possible for each of them to much exceed the limits that here put their respective adversaries *hors de combat*.

And now it is no longer necessary to dwell upon the explanation of a well-known acrobatic feat: a companion raining heavy blows upon an anvil that a "Hercules" supports upon his abdomen. In this case the arms and legs form an elastic support arranged like an arch, and which annuls the live power of the whole—hammer and anvil. There is here no deception, as spectators sometimes think, but merely a principle of mechanics well applied. Let the blow of the hammer be well applied also and the effect is always striking.—*La Nature.*

PROGRESS OF NAVAL ARCHITECTURE.

AT the recent meeting of the Institution of Naval Architects, London, Lord Ravensworth, the retiring president, pointed out that during the past year vessels of no less than four different types had been taken in hand. The first was the Campania, a twin-screw steamer of 13,000 tons. This new vessel comprised sundry special features, one of which was what is known as an "elliptic" stern. The engines would develop from 28,000 to 30,000 horse power, and it is anticipated that the Campania, as also her sister ship Lucania, would perform the voyage across the Atlantic in four and half days. The second vessel he referred to was the Trochino, which was claimed to be the fastest cruiser afloat, having achieved nearly 23 knots per hour under forced draught. The Trochino was a very heavily armored vessel, built for the Argentine Republic, of only 3,500 tons displacement, and yet had propelling machinery of 14,500 horse power. Two other ships

of a similar character were being built. The next vessel referred to was the remarkable yacht Valhalla, of 1,400 tons displacement, with an area of sail equal to that of a first class clipper. The vessel had attained a speed, under steam, of 10½ knots, and, under canvas, 11¼ knots. The third ship he would mention was a "turret" deck steamer of 18 feet draught, built on the Wear, and which was a modification of the "whaleback" steamer.

M. TAINE.

TAINE interested me in the same way that Holland did. Each work of his save one—and I am not sure whether it was an exception—was the fruit of dogged, persevering labor and of careful thought nourished with observation and the patient kind of study that an acute and sagacious lawyer might bestow upon an involved case in which he had to depend on piecing together minute bits of evidence. He had little intuition beyond a sense of duty and an instinctive belief in hard work. "Where there's a will there's a way," would have expressed the first article of his scheme of life. He was naturally disposed to like what was decent, orderly, kindly, and, it must be said also, "to love a lord," as he showed in his placing himself on the side of the ducal party at the French Academy. But though not intuitive, and owing so much to mental toil, he was highly original, and differed as greatly from each and all of his brilliant class-fellows of the Ecole Normale des Hautes Etudes as a Dutch town differs from a French town, or a Dutch landscape from any prospect that France can afford. Is there anything more picturesque, notwithstanding its flatness, than the scenery of the Netherlands, because of its extraordinary originality and the powerfully strong impression it forces home on the mind of the flat meadows, the formal and brightly blooming gardens, the clean, snug houses, the canals which light up the country by mirroring the sky in their placid waters—all being fruits of dogged and intelligent labor? For works of observation Taine was, to all appearance, disabled by defective sight. His eyes were so near-sighted that he could hardly read without holding the printed matter or writing close to his face. With this he squinted. Long spells of visual attention made his head giddy. This source of discomfort tended to disappear as he advanced in life. I also doubt whether in France he was in a congenial soil for his mental and moral growth, or that he was fully acclimatized. His English tastes were a case of atavism, his family being from Boulogne-sur-Mer, where he believed they must have mixed and intermarried time out of mind with the English. At any rate, his grandmother was English, and Taine learned as a child her mother tongue from one of her sons, who settled when young in America, and returned, an old man, to stay with his French relatives. This uncle was attached to Taine, finding fault only with his Christian name of Hippolyte, to which he could never get reconciled. I heard these particulars a good many years ago at the house of the author's brother at Orsay, where he was thriving in an unobtrusive way as a notary.

HIPPOLYTE ADOLPHE TAINE.—AFTER A PICTURE BY BONNAT.

Louis Blanc spoke of Taine as feeding his readers on tinned meats and vegetables which were far from keeping the promise they made to the palate and wholly wanting in natural aroma. He called his style *rocailleux*. There was a good deal in the criticism. Prince Napoleon, no bad critic either—of whom Taine used to be a respectful though not an obsequious courtier before the fall of the empire and the election of the Duc d'Aumale to the French Academy—called Taine, in his attack upon his study of the great Napoleon, "an artisan in mosaics." The portraits he did were composed atom by atom, were works of patience and decorative; but they had no inwardness, and were not therefore informing. Taine wanted discernment in choosing his materials. What he most sought for in them was capacity to dovetail with other bits and scraps that he had got hold of. Literary society and academicians raved about Taine's "Napoleon." They believed it to be true, and predicted for it immortality; but as they were lauding in the highest, Marbot's "Memoirs" came out and utterly shattered the cunningly executed mosaic into which no breath of life had been breathed.

Taine's theory, which he made the rule of his literary work, was that we are entirely the product of environment. Environment doubtless gives a general complexion, and possibly more, to the mind. When millions grow up in similar environments they have a family likeness, and are easily welded into a nation. Taine left so little place for intuition that there is a deadness in most of his writings, and not least in those into which he forced cleverness as if by means of a screw-press. They are bright enough, but life is wanting. Taine's studies on foreign lands and localities new to him that he visited are exceptions to his want of life, and the comparative studies on France and England the happiest of any. Mr. J. R. Robinson, with his keen instinct for what is capital journalistic matter, pounced on the advanced sheets of these studies and gave them in an English form to the readers of the *Daily News*. Indeed, whenever Taine went to England for a subject he was best inspired, for there his sympathies had fuller scope. The more active play widened his mental vision, and gave him afflatus. He found in England more than elsewhere the æsthetic virtue of idiosyncrasy strong to the point of breaking bounds, but did not learn to what a degree it may be independent of epoch and environment. The saying, "The wind bloweth where it listeth," had, I fear, no meaning for Taine, who only began to understand when it was too late that what is purely objective in the human being is mere dry bones unless there is a rich subjective side also to give it impetus and wings.

Taine was not merely out of touch with the French revolutionary spirit, but instinctively held it in aversion. He was almost blind to the work it did and is doing in the world. Notwithstanding the fatalism of

his philosophy, he was unable to perceive that revolutions must needs have been of frequent recurrence in France since the glacier of Romano-Feudal despotism was well melted for the first time by the participation of Louis XVI. as an ally of Washington in the war of American independence. The melted ice had to drag nasty drift with it, to form moraines, and in running down slopes to leap in cataracts, which are splendid things in their way, and can even be turned to industrial uses, but are impediments to navigation.

When I first saw Taine he was already rich—his books selling well and he having married the daughter of a wealthy decorative house painter. The meeting was in a railway carriage. He saw that I was reading the *Daily News*, and edged up to me to ask if I would, when I had done with it, lend it to him. Having done this and received the paper back, we fell into conversation, and the talk became to me most interesting. I knew that I was speaking to some first-rate man, but had no idea who he was, nor did he tell until we got to the end of the journey, when he gave me his name and address, and said that it would afford him great pleasure to go on at his house with the conversation. At that time he lived in the Rue Barbet de Jouey, after residing in a solemn-looking old house facing the Morgue and Notre Dame, in l'Ile St. Louis.

On the occasion I speak of, Taine struck me before he chatted as a solid, comfortably-off Belgian, of the Flemish provinces. He was fleshy but not corpulent, had well-shaped features and a massive head. The sandy beard was sparse, his hair a pale brown, and his face rather sallow and of a complexion rhyming with that word. The eyes were pleasant once he got into touch, they expressing kind, intelligent curiosity and honesty, the cast notwithstanding. His manners could not have been more unassuming. But to use an expressive French phrase, they were *bien poses*, and spoke of the habit of feeling a good position which relieved him from the need of pushing his way. Nobody could have been more free from that hateful vice of our day, the passion for self-advertisement. A photograph of his was never in the market. He sat with reluctance for his portrait as a staff writer of *Les Debats*. It was to be brought into a collective picture of all his then living colleagues for a history of that paper that was to appear on its centenary.

Taine's unobtrusive disposition led him to keep quietly in his home circle and to dread press publicity. There was firmness in his conduct toward himself and toward those by whom he was surrounded, but no masterfulness. The general conditions of Parisian life were not congenial to him. He recoiled from Paris and all its ways, and most of all from Boulevard prostitution of wit and talent, going to stay, as much as his family obligations and literary affairs would let him, to a place he built for himself on the lake of Annecy in Savoy. There he kept the best part of his library, and there he is buried. It may be said of him that he was in all things sincere, righteous of purpose, and of a goodly life.—*Spectavi, in Illustrated London News.*

THE CATERPILLAR OF HARPYA FAGI.

THE caterpillar of *Harpya Fagi* is one of the most curious that exist. As soon as it is hatched (eighteen days after the egg is laid), it throws its body actively to the right and left, with abrupt motions, for a whole day without eating anything. It has thus, with its long anterior legs, the appearance of an ant. Then it is seen to fix itself upon a stalk by means of silk threads in order to prepare itself for the first moult. In this position, it remains quiet for another day. It is only after it is delivered from this crisis that it begins to eat the leaves of the beech, horn-beam, birch and oak, but principally those of the first trees. It sometimes attacks the leaves by making a hole in the center.

After about three days, it moults for the second time. It undergoes six moults during the space of about sixty days, at the end of which it forms a thin and closely wound cocoon among mosses or leaves that shelters the chrysalis during the winter and till spring or the beginning of summer.

As lively as it is on making its exit from the egg, it soon becomes sluggish, and, at the last stage, it leaves the branch that has nourished it only when the latter is entirely devoured. It generally places itself under the branches or leaves so as to have its abdomen upward. During the state of repose, its head is reversed and sometimes even touches the posterior part, which is always raised. The long anterior legs, bent back upon the abdomen, complete this odd aspect, which becomes comical and menacing when the animal is disturbed. In such a case, one sees these four large legs quiver and elongate and the two caudal legs separate until quiet is restored.—*Le Naturaliste.*

THE CATERPILLAR OF THE BEECH HARPYA.

A BREED OF TAILLESS CATS.

THE most important objection that the public has to the Darwinian theory is the asserted impossibility for a species provided with a tail to lose that appendage. The example is constantly cited of the fighting dog, whose ears and tail are clipped for numerous generations, and yet always persist.

This, however, is not the only example in which mutilations of an ancestor are not reproduced in the progeniture. Thus, bulls whose horns have been removed only exceptionally beget calves that are deprived of them. The horns almost always persist. On the contrary, in Paraguay, oxen have spontaneously rid themselves of their horns, which permitted the inhabitants to capture them the more easily with the lasso, and a breed of hornless oxen has spontaneously formed.

TAILLESS CAT OF THE ISLE OF MAN.

There likewise exist tailless cats, and Mr. Adrien de Mortillet has just exhibited a specimen of these to the Society of Anthropology. It came from the Isle of Man. Darwin had already made known the presence of this variety in that island, saying, even, that it has longer hind legs and a larger head than the ordinary breed, and with different habits.

The specimen under consideration, however, absolutely resembles the common cat as regards habits and aspect, save that it is provided with but a stump of a tail covered with hairs 2 or 3 cm. in length, and similar to the tail of a rabbit, and which, like the latter, it frequently raises. The atrophied coccygeal vertebræ are perceptible to the touch.

Tailless cats abound in Japan, and those of the Isle of Man might well be derived from them. They may have descended from individuals brought from the far East by sailors. However, the cat was not introduced into the British Islands until the end of the ninth century.

Japanese artists have often taken this pretty animal as a model, and the absence of a tail strikes one in their drawings. Champfleury, in a volume entitled "Cats," recalls the engravings of a celebrated Japanese artist, Ho-Kou-sai or Fo-Kou-sai, who lived at the beginning of this century.

Tailless cats are not the bounden companions of the yellow race. In China, cats are provided with a very long tail; but in Malaisia, Siam and Burmany, they have a tail truncated about midway, and often terminating in a knot.

According to Leon Metchnikoff, the cats imported into the Isle of Java lost their tails at the beginning of the third or fourth generation. The Japanese cats may have been derived from this Malayan breed, for we know that frequent historical relations existed between these countries.

Now, cats without a tail are found especially on the coast of Japan, while in the interior the animals are provided with that appendage.

The breed of tailless cats has, however, been very little studied. Darwin was the first to make it known. Its existence in Japan has scarcely been noted except in two works: "The Japanese Empire" of Leon Metchnikoff and the "General History of Voyages," published by Didot. As for the Malayan cats, they have been described by William Marsden in his "Voyage to the Island of Sumatra," and by Dr. Morice in his "Voyage to Cochin China." The latter dwells upon the caudal appendage, but a few centimeters in length, and several times curved upon itself as if it had been broken several times in an opposite direction. This arrangement is so pronounced that these animals can be lifted by the hook of their tail, which, therefore, differs from that of the cats of Japan and the Isle of Man, which is still more atrophied.

Mr. Adrien de Mortillet has had the merit of calling attention to a breed of cats that is little known and not found mentioned in the classics. By crossing with a common cat, he will be able to see whether his female gives birth to young that are like herself, as has been already observed in England. He will thus introduce an original breed at Paris, and amateurs will, instead of proceeding by mutilation, like Alcibiades, endeavor to obtain a descendant of this she cat.

The man of science will obtain therefrom the impression that the tail is an appendage that is easily capable of disappearing. Medical men will have no occasion to be astonished, for examples have been cited of men who possessed a caudal appendage several centimeters in length, and that even necessitated the intervention of surgery. Although the presence of such appendages is really exceptional in the human race, have we not a right to regard that umbilicate depression that we find so frequently (one case out of eight or ten) in the coccygeal region of man, at the extremity of the vertebral column, as a reminder of the caudal prolongation? It is congenital, and sometimes reaches a depth of 2 or 3 centimeters, and is then like a fistula into which a stylet can be inserted. It forms the subject of a learned work by Messrs. Tourneux and Hermil, who have shown that it has often been the starting point of abscesses of this region.—*La Nature.*

KANGRA BUCKWHEAT.

(*Fagopyrum tataricum*, Gaertn., var. *himalaica*, Batalin.)

THE typical plant (*Fagopyrum tataricum*, Gaertn.) is cultivated throughout the higher Himalayas, but more especially on the western extremity, and at altitudes from 8,000 to 14,000 feet. It is a taller, much coarser plant than *F. esculentum*, and the nuts, which are long, and not triangular, have the angles rounded off, and keeled toward the top.

When first examined by Dr. Batalin at Petersburg, he was struck with the looseness of the pericarp and the ease with which it could be separated from the seeds. On this account he regarded the plant as likely to be useful for cultivation in Europe, where hitherto it was not known. The experience with it in Russia so far has not borne out this anticipation. In a letter received from Dr. Batalin, dated the 30th July last, he states, "As to the result of the cultivation of this *Fagopyrum*, I have noticed that the plants grow very vigorously, and produce an abundance of leaves, but [in this country, at least] the quantity of seeds harvested from them is extraordinarily small, and I do not believe the [Kangra] variety to be valuable enough for general cultivation in Russia." As regards the value of the seeds as an article of food, there can be little doubt that they are singularly rich in nutrient constituents. A sample of this buckwheat was communicated to Professor Church, F.R.S., who has been good enough to furnish the following particulars:

The seeds of Kangra after separation of the husk gave, on analysis, the following results in 100 parts:

Water	14·2
Albuminoids	12·7
Starch, etc., by difference	67·8
Oil	3·1
Fiber	0·7
Ash	1·5

It should be stated that the above percentage of albuminoids has been calculated on the usual supposition that the whole of the nitrogen present in the seeds exists in the albuminoid form. But the coagulable albuminoids, as estimated by the "phenol method,"

amount to 11·2 per cent. only, a difference which is by no means an unusual one. The ratio of albuminoids to carbohydrates plus the starch equivalent of the oil will then be 1:6⅔, instead of 1:6. The nutrient value of these seeds is about 87.

From the few data at my disposal I am inclined to consider this buckwheat as a particularly useful and valuable food grain. Its nutrient ratio is satisfactory; it contains a fair percentage of oil or fat; the indigestible fiber is singularly low, being less than one part in 100. The small proportion of husk and the extreme ease with which it may be separated from the seed are strongly in its favor.

COMMON BUCKWHEAT.

(*Fagopyrum esculentum*, Moench.)

This is the common buckwheat or brank of Central Europe and Asia, where it is grown as a food crop. It is popularly regarded as greatly inferior to wheat in nutritious properties, but to be superior to rice. In India it is extensively cultivated. Watt's *Dictionary of the Economic Products of India*, iii., 311, gives the analysis of a common buckwheat made by Professor Church, F.R.S., but not of Indian origin. At the time of the publication of the *Food Grains of India* in 1886, no authentic sample of Indian buckwheat had been communicated. This deficiency he has now been able to supply, as a sample reached him from India early in the present year. The results of the analysis by Professor Church are as follows:

100 of the fruits weighed 30 grains. The husk amounted to 18 per cent. by weight.

Composition of Buckwheat (husked).

Water	13·3	per cent.
Albuminoids	14·2	"
Starch	66·6	"
Oil	2·0	"
Fiber	1·9	"
Ash	2·0	"

The nutrient ratio is here 1:5, but when the albuminoids were determined by the phenol method this ratio becomes 1:5¼, for the percentage of albuminoids was reduced to 12·4. The nutrient value is 85·4.

On comparing the above percentages with those previously given for variety Kangra it will be noted that while the total nutrient value of the latter is higher, its proportion of albuminoids is lower. But, on the other hand, the presence of a smaller quantity of fiber, and of a larger quantity of oil, in the new variety, tells in its favor.—*Kew Bulletin.*

MANUFACTURE OF THE DIAMOND.

MR. HENRI MOISSAN, one of the youngest members of the Academy of Sciences, to whom we already owe, among other important labors, the isolation of fluorspar, has just solved a problem whose solution has haunted the brain of chemists and pretty women for many years. He has converted a vulgar piece of sugar into a genuine diamond.

It would not be necessary for that, confiding in the principle that "he who can do the most can do the least," to discount the approaching discovery of the classic philosopher's stone, and suppose that the same Mr. Moissan will soon point out to us a method of changing pennies into gold dollars. Such a reasoning by analogy would be very imprudent, for the two cases are very distinct.

In the present state of chemistry, in fact, every metal must be considered as a simple body, consisting of a single element possessing its own individuality and capable of alloyage or combinations, but that cannot be transformed into another simple body. In a word, it would be as difficult to convert a bar of iron or silver into gold as it would be to bring forth a rhinoceros from the body of a rabbit.

The psychology of the diamond presents itself under another aspect, which, quite disconcerting in appearance, is really very simple. Since the experiments of our great chemist Dumas and his Belgian confrere Stas it has been admitted without dispute that the diamond is carbon, that is to say, coal crystallized in a nearly pure state. In fact, if a diamond be burned in a balloon filled with oxygen, we find a little ashes and carbonic acid. As this latter, upon the identity of which it is impossible to be deceived, can result only from a combination of oxygen with carbon, it is evident that the diamond is carbon.

It will be conceived from this that scientists have foreseen the possibility of purifying this carbon, which constitutes the fundamental principle of coal, and which we find in a still more perfect state in lampblack and graphite, and of causing it to crystallize in the form of diamond.

Theoretically, the operation is very simple. It suffices to dissolve carbon in some medium or other and to evaporate the latter in order to obtain crystallized diamond. In practice great difficulties are encountered. Carbon is insoluble in all known liquids, and this body, so easy to burn, has long been reputed infusible. There is, indeed, the sulphide of carbon—a liquid and nauseous combination of sulphur and carbon, but the metamorphoses to which it was submitted by Gannol, as long ago as 1828, gave no serious result.

Chemists, having no basis of experiments, were therefore obliged to occupy themselves, in the first place, with determining the conditions under which the natural diamond is produced.

As it is met with sometimes in ferruginous sandstones and sometimes in alluvium, each one emits a different theory. We find partisans of a slow formation and of a sudden formation, at a high and at a low temperature, with or without the co-operation of steam and of great pressure, etc. In general, however, there has been a disposition to admit the influence of a heat and pressure that nature alone can develop.

Finally, one fine day there was no longer any hope except in electricity. This new force had already been utilized for burning the diamond, which had until then resisted the intensest fire. Despretz, struck by the example of water, which the passage of an electric current decomposes into oxygen and hydrogen, submitted a piece of charcoal to the action of quite a weak battery. At the end of a month he perceived upon the poles a microscopic deposit that he took for diamonds. A legend arose, and it is up to only a few days since that a large number of people have been persuaded that the artificial diamond was obtained long ago. Now the fact is that Despretz's dust was merely graphite. This Mr. Berthelot has demonstrated in a peremptory manner.

More recently, Mr. Marsden, an Englishman, employing a process similar to that with which Mr. Moissan succeeded, obtained results that he was unable to turn to account. The history of chemistry mentions a few other tentatives, the small number of which indicates the doubts of scientists as to the solution of a problem so seducing.

Despretz's experiment, however, was encouraging. Agglomerated graphite, which is quite abundant in nature, and is used for making lead pencils, is very rare in a crystallized state. Chemically purer than ordinary carbon or lamp-black, it occupies a place intermediate between the latter body and the black

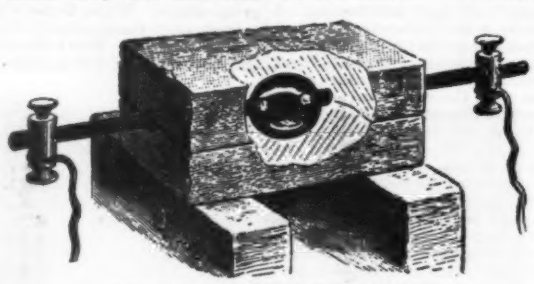


FIG. 1.—ELECTRIC FURNACE.

diamond, and it scratches the ruby. Since we had reached graphite from carbon, why was it not possible to cross the interval that separates the former from the diamond?

Mr. Moissan early made this reasoning. When he was preparator to Mr. Deherain at the museum, he daily passed into the great hall where is to be seen, opposite a huge block of natural rock crystal, a section containing artificial rock crystals weighing scarcely more than a few centigrams. He often said to himself that we ought likewise to obtain artificial diamonds, but that if the power of man succeeded in producing only a few centigrams of a material that nature manufactures in so large specimens, we could, *a fortiori*, demand of it only milligrams of the diamond, of which nature prepares so small bits; so one fine day he attacked the problem of the crystallization of carbon.

Like his predecessors, but with more patience, and perhaps with more method, he in the first place endeavored to form a personal opinion as to the circumstances that have possibly surrounded the genesis of the precious stone.

In closely studying the blue earth of the Cape, so rich in diamonds and that we all saw triturated at the Exposition of 1889, he was struck with the place that iron or its derivatives occupies in its composition.

The existence of the diamond in a meteorite was soon a new streak of light.

He then amused himself with burning diamonds, and during the last four years he has consumed more than six hundred dollars' worth of them. At this cost he acquired the certainty, through an examination of the ashes, that the purest diamond contains traces of iron. Remembering then that, like other metals, iron in fusion dissolves a certain quantity of carbon, and that, in addition, it possesses alone with silver and water the odd property of increasing in bulk when it is passing from the liquid to the solid state, he believed it

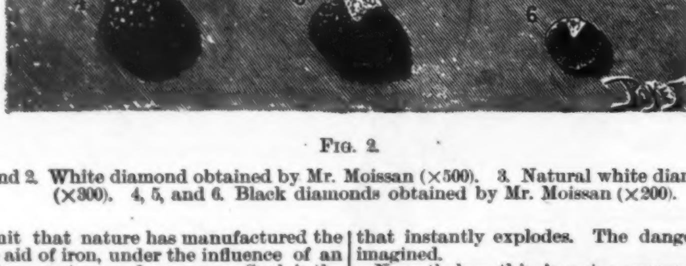


FIG. 2.

1 and 2. White diamond obtained by Mr. Moissan (×500). 3. Natural white diamond (×300). 4, 5, and 6. Black diamonds obtained by Mr. Moissan (×200).

possible to admit that nature has manufactured the diamond by the aid of iron, under the influence of an extremely high temperature and pressure. Such is the starting point of the experiments that have yielded him so brilliant results.

A cylinder of soft iron packed with carbon of sugar is placed in a crucible filled with molten iron, raised to a temperature of 3,000° by means of an electric furnace. In the presence of such a heat, this cylinder itself instantly melts and dissolves a large quantity of carbon. The crucible is immediately taken from the furnace and thrown into a pail of water. In this way is brought about the rapid formation of a layer of solid iron. As soon as it is of a dull red the whole is taken from the water and the cooling is allowed to proceed in the air.

In measure as the temperature of the iron still liquid in the interior lowers, the metal is obliged to give up a portion of the carbon that it had dissolved, and, as its expansion is interfered with by the crust that imprisons it, there is developed an enormous pressure which brings about a crystallization of what was sugar.

Let us note, by the way, that the success of the operation must not be attributed, as one might think and as has been claimed, to the use of the electric furnace. This apparatus, which has been known for some time, is very simple. It consists of two refractory bricks inclosing a crucible above which arrive two electric wires between which a voltaic arc is produced. Mr. Moissan raises the temperature of the molten iron to 3,000° in order to saturate it still further with carbon, and to thus have a chance of producing more crystals.

The bottom of the crucible sawed off when cold shows points as large as the head of a pin on its edges; it is the diamond. In order to isolate it, it suffices to treat the block with acids, which destroy all the other bodies.

Mr. Moissan has thus obtained a few milligrams of black diamond and several particles of white diamond. The first, examined under the microscope, presents itself under the form of black octahedrons with angles sometimes rounded, or, if the crystallization is more advanced, with a transparent facet. The second absolutely resembles the natural diamond, with the same crystalline form and identical striæ, "imbibing light," to use the picturesque expression of the jeweler. It has, like the black diamond, that very characteristic aspect that no other crystal possesses.

Finally, the Moissan diamond scratches the ruby; burned in oxygen, it gives carbonic acid; and, supreme criterion, its density is equal to that of the natural diamond—3·5, while that of graphite reaches 2 only.

No doubt, then, seems possible; Mr. Moissan has manufactured genuine diamonds. Mr. Berthelot, who has devoted himself to analogous researches, has himself recognized the fact, declaring that the result obtained by his confrere renders it unnecessary to pursue his own experiments.

Is there any chance of Mr. Moissan obtaining larger crystals and of rendering his process industrial? That is the troublesome question.

It has been stated that this dust cost the young academician over six hundred dollars. That is correct, but such cost represents several years of groping in the dark and of preparatory study, and especially, as we have already said, of burned diamond. Hereafter the expense will be reduced to iron, carbon and electric heat and to a few acids, that is to say, a trifle.

What most disturbs our scientist is the impossibility of operating upon masses large enough to give voluminous crystals. At the moment the crucible is thrown into the water a portion of the latter is decomposed, and the mixture of oxygen and hydrogen that is disengaged may in igniting form a detonating compound that instantly explodes. The danger may be easily imagined.

Nevertheless, this is not a reason for prejudging of the future. Let us recall the experiments of Ebelman. It was in 1847 that he converted aluminum into rubies. The crystals that he obtained, and that are still exhibited at the Sevres manufactory, were very small. Scarcely any one dared to risk a repetition of these experiments. Two years ago, however, Mr. Fremy improved the process, and, with a little potter's clay, rubies weighing a carat are now manufactured.

Whatever be the industrial outcome of Mr. Moissan's discovery, the secret of which he has given up with so much disinterestedness, it will remain one of the most brilliant of the century.—*L'Illustration.*

RESEARCHES ON DIAMONDS.

A further communication from Mr. Moissan concerning the chemical properties of the diamond is contrib-

uted to the current number of the *Comptes Rendus*. In the first place, precise determinations have been carried out of the temperatures at which various kinds of diamonds undergo combustion in pure oxygen. As the action of oxygen upon the diamond has so long been known, it appears somewhat singular that, as Mr. Moissan states, no exact data concerning the temperature of combustion should hitherto have been obtained. It will doubtless be remembered that Dumas and Stas, in their celebrated experiments in connection with their determination of the atomic weight of carbon, burnt diamonds in a current of oxygen in a porcelain tube heated in an ordinary earthenware table furnace. Other chemists have since performed similar experiments with the aid of the combustion furnaces employed in organic analysis. In order to be able to determine the temperature of such combustion with precision, Mr. Moissan has employed a modification of Le Chatelier's thermo-electric apparatus, placed along with the diamond in a wide porcelain tube closed at the ends with glass plates through which the combustion in oxygen could be viewed. It was found that when the temperature is slowly raised under these conditions the combustion proceeds gradually without the production of light. But if the temperature is raised 40° or 50° above the point at which this slow combustion commences, a sudden incandescence occurs, and the diamond becomes surrounded by a brilliant flame. Various deeply colored specimens of diamonds burned with production of incandescence and flame at temperatures of 690°-720°, but transparent Brazilian diamonds did not attain the stage of slow combustion without incandescence till the temperature of 760°-770° was reached. A Cape diamond suffered gradual combustion at 780°-790°. Specimens of exceedingly hard boort likewise commenced to combine with oxygen at 790°, and burned brilliantly at 840°-875°. When Cape diamonds were heated in a current of hydrogen to a temperature of 1,200° they remained unchanged; but if the stones had previously been cut they frequently lost their brilliance and transparency. Dry chlorine gas was found incapable of reacting with the diamond until a temperature of 1,100°-1,200° was attained. Hydrofluoric acid vapor likewise only reacted at about the same high temperature. Vapor of sulphur also requires to be heated to 1000° before reacting, but in the case of black diamonds, bisulphide of carbon is produced at about 900°. Metallic iron, at its melting point, combines with the diamond in a most energetic manner, and it is a point of considerable interest that crystals of graphite are deposited as the fused mass cools; hence the experiment forms a striking mode of converting the allotropic form of carbon which crystallizes in the cubic system into that which crystallizes in the hexagonal system. Melted platinum likewise combines with the diamond with great energy. A most curious reaction has been observed to occur between the diamond and the carbonates of potassium and sodium. When a diamond is placed in the fused carbonate contained in a platinum dish it rapidly disappears, and carbonic oxide is copiously evolved. Fused niter or potassium chlorate, however, have not been observed to exert any action upon diamonds.—*Nature.*

THE CHEMISTRY OF OSMIUM.

AN important addition to our knowledge of the chemical nature of this interesting element is contributed by Prof. Moraht and Dr. Wischin, of Munich, to the current number of the *Zeitschrift fur Anorganische Chemie.* Two years have scarcely elapsed since the position of osmium in the periodic system was finally decided by the painstaking redetermination of its atomic weight by Prof. Seubert. Previous determinations of the atomic weight of osmium had been made with material which Seubert subsequently showed to be impure, and in consequence the erroneous value 198·6 had been ascribed to it. Indeed previous to the year 1878 the order of precedence as regards atomic weight of the four metals of the platinum group—gold 196·2, iridium 196·7, platinum 196·7, and osmium 198·6—was entirely at variance with the order demanded by their chemical and physical properties, and a standing contradiction of the periodic law of Newlands and Mendeleef. In that year, however, Seubert attacked the case of iridium, and as the result of a series of determinations, made with the laborious care which has characterized all his work, the atomic weight of this metal, when obtained in a pure state, was shown to be 192·5, a number very different to that previously assigned to it, and which was afterward remarkably confirmed, even to the decimal place, by an independent investigation by Joly. Three years later Seubert made his celebrated redetermination of the atomic weight of platinum, which resulted in the number 194·3 being finally derived for the true atomic weight of the perfectly pure metal. This value was likewise subsequently confirmed by Halberstadt. In the year 1887 the position of gold was decided by simultaneous independent redeterminations of its atomic weight by Thorpe and Laurie in this country and Kruss in Germany, the two values being practically identical, 196·7. Lastly, in 1891, Seubert completed his work by redetermining the atomic weight of osmium with a specimen of the metal of practically perfect purity, with the result that the old number, 198·6, was found to be entirely erroneous, due to considerable quantities of impurities being present in the samples previously employed, and that the real value of this constant was 190·3, thus removing osmium from its former situation at the end of the series and placing it in its proper position at the head of it.

The order of precedence of the metals of the platinum group is therefore as follows: Osmium 190·3, iridium 192·5, platinum 194·3, and gold 196·7. This order is in full accordance with the relative chemical and physical properties of these metals, and the last outstanding exception to the periodic generalization has disappeared.

Although the properties of pure metallic osmium, and particularly its atomic weight, are now known with certainty, the nature of its compounds is yet very little understood. Moreover, it is evident from the result of the investigation of Prof. Seubert that previous workers have been dealing with an impure metal of atomic weight 198·6. It was therefore desirable that not only should the chemistry of this element be extended to compounds hitherto uninvestigated, but that the composition and properties of the compounds already known should be subjected to a re-examination.

Prof. Moraht and Dr. Wischin have therefore taken up the study of the compounds of osmium with oxygen, sulphur, and the halogens, employing material of a very high degree of purity, and the results of their investigation are both novel and interesting.

Work with osmium compounds is endowed with peculiar personal danger to the chemist, owing to the great facility exhibited under the most various conditions for the formation of the tetroxide OsO_4, a substance which boils at 100° C., and is very volatile at the ordinary temperature, and which attacks the skin, the lungs, and particularly the eyes with most serious consequences.

The material started with was a comparatively pure sample of the best known salt containing osmium, potassium osmate, $K_2OsO_4 \cdot 2H_2O$. This salt was further purified by distillation with nitric acid or aqua regia and absorption of the liberated tetroxide vapors in a solution of caustic potash. The dark brown solution of potassium perosmate thus formed was largely diluted with water, and reduced to osmate by the addition of alcohol. After the expiration of about 24 hours almost the whole of the osmium had separated in the form of beautiful little crimson octahedrons of the salt $K_2OsO_4 \cdot 2H_2O$, which, after washing with dilute alcohol, proved to be quite free from impurity, showing no trace of iridium.

Previous observers have noticed that an aqueous solution of *potassium osmate*, K_2OsO_4, is most remarkably affected by sunlight, a rapid decomposition being brought about with deposition of a black precipitate to which the composition $OsO_2 \cdot 2H_2O$ has been ascribed. The specimens experimented with, however, undoubtedly contained iridium, and it was therefore of interest to investigate the action of sunlight upon solutions of the pure salt just described. When the crimson octahedrons of pure $K_2OsO_4 \cdot 2H_2O$ were dissolved in cold water, and the clear reddish violet-colored solution was exposed to direct sunshine, no evidence of change was apparent for several days, but the moment the vessel containing the solution was immersed in a bath of boiling water, while in bright sunshine, decomposition commenced, and a black precipitate rapidly accumulated, until after the expiration of two or three hours the whole of the osmium present was deposited. As there is a marked tendency for the production of the noxious fumes of osmium tetroxide during this decomposition of the hot osmate solution by the waves of light, it is best to take the precaution of reducing their amount to a minimum by the addition of a little alcohol, which acts as a strong reducing agent under these circumstances, and by passing a stream of hydrogen through the solution during the whole operation. The precipitate is usually so finely divided that considerable difficulty is experienced in separating it from the solution. The filtration succeeds best when the filter is previously moistened with dilute acetic acid, when a clear colorless filtrate is usually at once obtained. The precipitate cannot be dried in a warm air bath, as it is largely converted thereby into the volatile osmium tetroxide. It may safely, however, be dried over phosphoric anhydride in the vacuum of an air pump.

The accurate analysis of an insoluble substance of the nature of this precipitate, and containing a metal such as osmium, which so readily oxidizes to the volatile tetroxide, is a task of exceptional difficulty. The usual method of reduction to metal in a stream of hydrogen is insufficient, for more or less of the tetroxide is always formed during the process, necessitating the use of an absorption apparatus containing a solution of caustic potash, placed in front of the tube containing calcium chloride to absorb the water formed. The difficulty is, then, how to estimate the small quantity of osmium thus dissolved in the large excess of alkali.

It was eventually found that the weak electric current from three Daniell's cells precipitates the whole of the osmium from such a solution, contained in a nickel dish which forms the negative electrode, in the form of pure *osmium dioxide*, OsO_2, which may conveniently be dried *in vacuo* over phosphoric anhydride and weighed as such.

By this mode of analysis the interesting fact was eventually elicited that the black insoluble substance formed by the action of light upon a hot solution of potassium osmate is not, as was previously supposed, a hydrate of osmium dioxide of the composition $OsO_2 \cdot 2H_2O$, but is no other than free *osmic acid* itself, the hydrate of osmium trioxide, $OsO_3 \cdot H_2O$ or H_2OsO_4. Osmic acid is thus formed by the direct action of water, under the influence of sunlight and slight rise of temperature, upon the potassium salt. This remarkable change is expressed by the simple equation:

$$K_2OsO_4 + 2H_2O = H_2OsO_4 + 2KOH.$$

The liquid, as soon as the change commences, is observed to exhibit a strong alkaline reaction, becoming, as indicated in the equation, a solution of caustic potash.

It is singular that the presence of alcohol and the passage of a current of hydrogen during the reaction do not cause any reduction, serving only to hinder the further oxidation to the state of tetroxide. Indeed, if the crimson octahedral crystals of potassium osmate are covered in sunshine with warm alcohol and a current of hydrogen is allowed to bubble through the liquid, no trace of blackening is observed upon the faces of the crystals. The moment water is added, however, decomposition is immediately brought about.

Osmic acid, H_2OsO_4, is a soot-black powder, which fumes strongly in moist air, owing to its rapid conversion into the volatile osmium tetroxide, OsO_4, but which is quite permanent at the ordinary temperature when preserved under water containing alcohol. It dissolves readily in nitric acid, with formation of the hydrate of osmium tetroxide, the so-called per-osmic acid.

Cold hydrochloric acid attacks it but very slightly. Upon warming, however, it is entirely soluble, forming an olive green liquid, which will be subsequently considered, with liberation of a small quantity of chlorine. Sulphuric acid does not attack it. Osmic acid reacts in a most energetic and interesting manner with sulphureted hydrogen gas. Even in the dry state at the ordinary temperature the reaction proceeds with considerable violence. If the experiment is conducted in a piece of combustion tubing, upon which a bulb has been blown for the reception of the osmic acid, the moment that the gas enters the tube the whole of the black powder immediately becomes incandescent, and drops of water and a large quantity of free sulphur are deposited in the portion of the tube not heated by the reacting substances. The residual product of the reaction is a brown powder, which has been found to be a hydrated oxysulphide of osmium of the composition $2OsSO \cdot H_2O$.

The reaction occurs in accordance with the equation—

$$2H_2OsO_4 + 4H_2S = 2OsSO.H_2O + 5H_2O + 2S.$$

This *oxysulphide of osmium* is soluble in acids with decomposition, even sulphuric acid decomposing it with evolution of sulphureted hydrogen. It possesses acid properties, for it liberates carbon dioxide from carbonate of soda and sulphureted hydrogen when fused with sulphide of potassium. It would, moreover, appear to contain SH groups, for it yields mercaptan upon treatment with soda and ethyl iodide, the osmium being reduced to the dioxide OsO_2. Its probable constitution is therefore represented by the graphic formula:

$$\begin{array}{l} \quad\diagup SH \\ Os{=}O \\ \quad\rangle O \\ Os{=}O \\ \quad\diagdown SH \end{array}$$

When this oxysulphide is warmed in dry sulphureted hydrogen another violent reaction occurs, the whole mass again becomes incandescent, and the whole of the oxygen is eliminated in the form of water. The product of this second reaction with sulphureted hydrogen is pure *osmium disulphide* OsS_2.

$$Os_2O_3(SH)_2 + 2H_2S = 2OsS_2 + 3H_2O.$$

Of the *halogen* compounds of osmium only the chlorides have been at all investigated, chiefly by Claus, whose observations may be summarized in a few words.

When finely powdered metallic osmium is heated in a stream of dry chlorine, sublimates are formed. The first chlorine compound formed its chromous green in color, but is only produced to a very slight extent. There is next deposited a dense black sublimate, and finally a smaller quantity of a sublimate of the color of red lead. None of these three chlorine compounds are crystalline. Claus subsequently stated that the lowest chloride $OsCl_2$ is a bluish-black solid when isolated, and forms a dark bluish violet solution; the sesquichloride Os_2Cl_6 is reddish brown in the solid state, and gives with water a rose-red colored solution, and the dichloride $OsCl_2$ is the compound which exhibits the color of red lead, and yields a lemon yellow solution.

These observations of Claus are completely confirmed by the experiments of Prof. Moraht and Dr. Wischin, who, however, have extended them, and have been able to isolate other and higher chlorides of osmium.

They commenced by warming a large quantity of the free osmic acid above described for two days upon a water bath with concentrated hydrochloric acid, the flask in which the reaction was conducted being connected with an upright condenser. A little alcohol was added in order to prevent the formation of osmium tetroxide. The osmic acid eventually entirely dissolved, with formation of the dark olive green colored solution previously incidentally mentioned, a little chlorine being evolved at the commencement of the operation. It was found impossible to evaporate the solution upon the water bath without decomposition, but evaporation *in vacuo* over sulphuric acid and solid caustic potash, the latter to absorb the hydrochloric acid, succeeded admirably. The solid left after complete evaporation consisted of well formed crystals which assumed the habit of six-sided pyramids. These crystals were dark olive green in color when moist, but when the last traces of superfluous water were removed, exhibited a bright vermilion color. They were readily soluble in water and alcohol, the solutions being colored dark green, and the salt may be recrystallized from these solvents. Upon analysis they were found to consist of the chloride Os_2Cl_7 crystallized with seven molecules of water.

This chloride of osmium, $Os_2Cl_7 \cdot 7H_2O$, would appear to be a molecular compound of the *trichloride*, $OsCl_3$, and the *tetrachloride*, $OsCl_4$. For when potassium chloride solution is added to the solution of the crystals in alcohol, a precipitate of brilliant red octahedrons and cubes of potassium osmichloride, K_2OsCl_6, is obtained, showing the presence of *osmium tertrachloride*, $OsCl_4$. Moreover, when the precipitate is separated by filtration, and the filtrate concentrated by evaporation *in vacuo*, dark green crystals of the *trichloride*, $OsCl_3$, are deposited containing three molecules of water of crystallization.

During the reduction of these crystals of the trichloride in a current of hydrogen for the purposes of analysis, a small quantity of a white sublimate was obtained, which probably consisted of the *octo-chloride*, $OsCl_8$, corresponding to the tetroxide OsO_4.

Bromine does not react with osmium with anything like the energy of chlorine. The free elements do not appear to combine at all, even at moderately high temperatures. Only a small quantity of a sublimate of a dark brown color is obtained by passing bromine vapor over osmic acid. This sublimate dissolves to a brown solution in water, which, however, rapidly decomposes with deposition of a black precipitate.

When osmic acid, H_2OsO_4, is treated with hydrobromic acid in the manner just described in the case of hydrochloric acid, a similar reaction occurs with formation of a clear reddish brown solution which yields, upon evaporation *in vacuo* over sulphuric acid and solid caustic potash, small crystals of a molecular compound of the *tribromide*, $OsBr_3$, and the *hexabromide*, $OsBr_6$, together with six molecules of water of crystallization. These crystals of $Os_2Br_9 \cdot 6H_2O$ are dark reddish brown in color and exhibit a beautiful metallic luster. They are quite stable when preserved in a dry atmosphere, but rapidly deliquesce in moist air.

Iodine appears to possess even less affinity for osmium than bromine. When, however, osmic acid is treated with hydriodic acid, a deep greenish-brown

solution is obtained which deposits *in vacuo* dark violet rhombohedrons, exhibiting a brilliant metallic luster, consisting of the anhydrous *tetra-iodide of osmium*, OsI_4. This iodide, the only one containing osmium yet prepared, is permanent in a dry atmosphere at the ordinary temperature, but rapidly deliquesces like the bromide when exposed to moist air.

In relative stability the chloride, bromide and iodide of osmium above described exhibit a gradation such as would be expected from the relations between the halogen elements themselves. The iodide is readily dissociated by slightly raising the temperature, and upon the addition of water is decomposed with the deposition of a black precipitate containing the metal. A similar decomposition occurs, although much more slowly, in case of the bromide. The chloride, however, is well nigh permanent under these conditions, only exhibiting traces of decomposition after the lapse of a considerable time. A. E. TUTTON.

USE OF MARINE SALT FOR THE REMOVAL OF SNOW—ELECTROLYTIC PROCESSES OF DISINFECTION.

THE removal of the snow that fell in the streets of Paris during the last storm was effected with remarkable rapidity, owing to the use of marine salt thrown upon the ground, either by the shovel or by means of Lesur machines. The warm wind that intervened played a considerable *role* in the rapidity of the operation, it is true, but it is none the less true that Mr. D'Ussel's method of salting, by rendering the enormous quantity of snow and mud semi-liquid, gives by that fact excellent results.

It is wrongly claimed that the salt employed in the melting of snow is "codfish salt," derived from fish salting works, but this legend is absolutely incorrect. The salt of fish salting establishments is, in fact, converted in great part into brine; the remainder, contaminated with ammoniacal odors and compound ammonias, methylamine, tri-methylamine, oils and fats, would diffuse odors such that the carriage, and especially the storage, of it while awaiting a fall of snow would render its use impossible. What really is used is marine salt, altered in its nature by tarry matters, that is to say, purposely contaminated so that it cannot be delivered for consumption. It is in this form, too, that the salt is delivered to manufactories of chemical products, which use it, for example, as a crude material for the manufacture of soda.

The chloride of sodium thus employed is indifferently either marine salt derived from salt marshes or crystallized salt from salt works. It is very difficult, moreover, to distinguish one from the other, save by taste. The salt derived from salt marshes has, in truth, a special taste due to the fact that it is mixed with chlorides of magnesium and potassium and with iodides and bromides, but all these in very small proportion, and it would take a skillful chemist to detect them. It is none the less true that housewives recognize as coarse salt, kitchen salt or marine salt, only bay salt in large crystals, which, according to them, possesses a salting power greater than that of ordinary white salt. In order to satisfy the whims of customers, the following is the process used in the state salt works:

After having dissolved the subterranean strata in water and pumped up this latter and evaporated it in basins, there is obtained, by disturbing the crystallization, the large crystals desired by housewives. This is the first step made, but these crystals are of immaculate whiteness. It is therefore necessary to give them the tint that will gain for them the maritime inscription in kitchens. To this effect, the material obtained is placed in heaps and the desired grayish tint is given it by dusting it with a grayish clay in fine powder that is absolutely harmless to the consumer. By turning over with the shovel and mixing and stirring the whole, the optical concession demanded is realized. The gray salt thus obtained passes in all kitchens for marine salt, of which it has sensibly all the qualities.

What Engineer D'Ussel had not foreseen when he taught us how to salt the streets and boulevards of Paris was that it was classed thus, from a chemical point of view, among the hygienists. Salt in its quality of chloride is, in fact, a remarkable antiseptic, for it contains, as its principal element, chlorine, which is the decolorizing, bleaching and purifying agent *par excellence* after ozone and oxygen. It is therefore an excellent thing to water the public streets with salted water. The microbes, at once salted and frozen, lose their noxious qualities and go to finish their career in the water of the river, where oxygen finally burns them up.

We should be in nowise astonished if, through a logical extension of the principles of hygiene, the streets of large cities came to be salted even in summer. We know, in fact, that through Mr. Hermite's electric processes it is possible to electrolyze marine salt and the chlorides in general, so as to obtain a solution at once decolorizing and disinfecting. When one is at the seaside the crude material is all indicated; it is sea water. When one is remote from the coast the solution to be electrolyzed is prepared by dissolving 25 kilogrammes of salt in a cubic meter of water. The electrolysis of this solution, that is to say, the elementry decomposition through the passage of an electric current, produces hypochlorites or other oxygenated compounds of chlorine possessing a high degree of oxidizing power, and of which infectious germs have a profound horror. At the same time these compounds oxidize and convert into harmless products hydrosulphuric acid or sulphureted hydrogen, and ammonia and its congeners, and all that vitiates the air. This system has been employed in England by Mr. Webster and at Rouen by Mr. Hermite. At first it did not give all the results that were expected of it, because the first attack was made upon the masses of polluted sewage water produced by cities. One would very likely have had much more success in dangerous periods of heat and dryness by preparing these electrolytic solutions and distributing them over the public thoroughfares by means of the usual watering carts, which would go to be filled at small municipal works created to this effect.

It is not absolutely proved that it is harmless to water the streets in summer with river water already infected and charged with germs. Such water, it is true, produces a coolness, but after its evaporation it evidently leaves in the dust of the street a host of dried bacilli that the wind carries away and scatters around. From this it appears logical to destroy them in the first place, in large proportion, by the antiseptic watering that we have just briefly described, and that has the advantage over many other processes of chemical disinfection of not costing very much.—*Le Genie Civil.*

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